Clinical Quality and Performance Measurement in the Prehospital Emergency Medical Services in the Low-to-Middle-Income Country Setting

Developing clinical quality and performance indicators as a measure of care in South Africa

By
Ian Lucas Howard

Dissertation presented for the degree of

Doctor of Emergency Medicine in the
Division of Emergency Medicine
Stellenbosch University, Stellenbosch, South Africa

and

Doctor of Medical Science in the
Department of Clinical Science and Education
Karolinska Institutet, Stockholm, Sweden

December 2020

Principal Supervisors:
Veronica Lindström
Karolinska Institutet
Department of Neurobiology,
Care Sciences & Society
Stockholm, Sweden

Lee Wallis
Stellenbosch University
Division of Emergency Medicine
Stellenbosch, South Africa

Co-supervisor:
Peter Cameron
Monash University
Department of Public Health
& Preventative Medicine
Melbourne, Australia

Maaret Castrén
Helsinki University
Department of Emergency Medicine
& Services
Helsinki, Finland

Opponent:
Piritta Setälä
Tampere University
Department of Emergency Medical Services
Tampere, Finland

Examination Board:
Anna Kristensson Ekwall
Lund University
Department of Health Sciences
Lund, Sweden

Rene English
Stellenbosch University
Department of Public Health
Stellenbosch, South Africa

Simon Carley
Manchester Metropolitan University
Faculty of Health, Social Care & Psychology
Manchester, United Kingdom

Christer Svensén
Karolinska Institutet
Department of Clinical Science & Education KI SÖS
Stockholm, Sweden

Zarina Nahar Kabir
Karolinska Institutet
Department of Neurobiology, Care Science & Society
Stockholm, Sweden

For Louisa, Mia, Layla, Amina, Brodie and Winston

"Every system is perfectly designed to get the results it gets…

If we want better outcomes, we must change something in the system. To do this we need to understand our systems."

-W Edwards Deming/Paul Batalden

DECLARATION

By submitting this dissertation electronically, I declare that the entirety of the work contained therein is my own, original work, that I am the sole author thereof (save to the extent explicitly otherwise stated), that reproduction and publication thereof by Stellenbosch University will not infringe any third-party rights and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

December 2020

ABSTRACT

BACKGROUND

Measuring quality and safety in any healthcare setting however is highly contextual, and depends on the manner in which quality is defined or viewed within that setting. It is this contextual nature that has provoked significant debate and hindered efforts at developing formal standards or criteria for measuring quality and safety in healthcare, regardless of setting. Historically, performance within the Emergency Medical Services (EMS) delivering prehospital emergency care has been assessed primarily based on response times. While easy to measure and valued by the public, overall, response time targets are a poor predictor of quality of care and clinical outcomes.

AIM

The overall aim of the research was to develop a framework for clinical quality and performance-based assessment of prehospital emergency care for use in the South African EMS.

METHOD

The research was divided amongst four studies, with each study constituting one of the overall research objectives. **Study I** was a sequential explanatory mixed methods study with the aim of understanding the knowledge, attitudes and practices of clinical quality and performance assessment amongst South African EMS personnel. Part 1 consisted of a web-based cross-sectional survey, and Part 2 consisted of semi-structured telephonic interviews of select participants from Part 1 to explore the results of the survey. Descriptive statistics were carried out to summarise and present all survey items, and conventional content analysis employed to analyse the interview data. **Study II** utilised a three round modified Delphi study to identify, refine and review a list of appropriate quality indicators for potential use in the South African EMS setting. For **Study III** a novel quality indicator appraisal protocol was developed consisting of two categorical-based appraisal methods, combined with the qualitative analysis of their consensus application, and tested against the outcomes of Study II. Descriptive statistics were utilised to describe and summarize the categorical based appraisal data. Inter-rater reliability was calculated using percentage agreement and Gwet's AC1. Correlation between the individual methods and the protocol was calculated using Spearman's rank Correlation and z-test. Conventional content analysis was utilised to analyse the group discussions. **Study IV** utilised a multiple exploratory case study design to evaluate the current state of quality systems in the South African EMS. A formative assessment was conducted on the quality systems of four provincial EMS and one national private EMS, following which semi-structured interviews were conducted to further explore the results obtained from the formative assessment, supported by multiple secondary data sources. Descriptive statistics were utilised to describe and summarize the formative assessment. Conventional content analysis was utilised to analyse the interview data and document analysis utilised to sort and analyse the supporting data.

RESULTS

Despite relatively poor knowledge of organisational-specific quality systems, understanding of the core components and importance of quality systems was demonstrated. The role of these systems in the Low to Middle Income Country setting (LMICs) was supported by participants, where the importance of context, system transparency, reliability and validity were essential towards achieving ongoing success and utilisation. The role of leadership and communication towards the effective facilitation of such a system was equally identified. Participating services generally scored higher for structure and planning. Measurement and improvement were found to be more dependent on utilisation and perceived mandate. There was a relatively strong focus on clinical quality assessment within the private service, whereas in the provincial systems, measures were exclusively restricted to call times with little focus on clinical care. Staff engagement and programme evaluation were generally among the lowest scores. A multitude of contextual factors were identified that affected the effectiveness of quality systems, centred around leadership, vision and mission, and quality system infrastructure and capacity, guided by the need for comprehensive yet pragmatic strategic policies and standards. A total, 104 quality indicators reached consensus agreement including, 90 clinical QIs, across 15 subcategories, and 14 non-clinical QIs across two subcategories. Amongst the clinical category, airway management (n=13 QIs; 14%); out-of-hospital cardiac arrest (n=13 QIs; 14%); and acute coronary syndromes (n=11 QIs; 12%) made up the majority. Within the non-clinical category, adverse events made up the significant majority with nine QIs (64%). There was mixed inter-rater reliability of the individual methods. There was similarly poor to moderate correlation of the results obtained between the individual methods (Spearman's rank correlation=0.42,$p<0.001$). From a series of 104 QIs, 11 were identified that were shared between the individual methods. A further 19 QIs were identified and not shared by each method, highlighting the benefits of a multimethod approach.

CONCLUSION

For the purposes of this study we focused on the technical competence aspect of quality, in developing our measurement framework. Towards this, we identified a significant number of QIs assessed to be valid and feasible for the South African prehospital emergency care setting. The majority of which are centred around clinically focused processes of care, measures that are lacking in current performance assessment in EMS in South Africa. However, we also discovered the importance and influencing role of the individual practitioners and quality system in which the QIs will be implemented, a point highlighted across all the methodologies and studies. Given the potential magnitude of this influence, it is of the utmost importance that any measurement framework examining technical quality, have equal in-depth understanding of these factors in order to be successful.

LIST OF SCIENTIFIC PAPERS

I. **Howard I**, Cameron P, Castrén M, Wallis L, Lindström V.
Knowledge, attitudes and practices of clinical quality and performance assessment among emergency medical services personnel in South Africa: A mixed methods study. Emergency Medicine Australasia. 2019; 31(6): 1024-1036

II. **Howard I**, Cameron P, Wallis L, Castrén M, Lindström V.
Identifying quality indicators for prehospital emergency care services in the low to middle income setting: The South African perspective. African Journal of Emergency Medicine. 2019; 9(4): 185-192

III. **Howard I**, Cameron P, Castrén M, Wallis L, Lindström V.
Multi-method appraisal of clinical quality indicators for the Emergency Medical Services in the low-and-Middle-Income Setting: The South African Perspective. (unpublished manuscript)

IV. **Howard I**, Cameron P, Wallis L, Castrén M, Lindström V.
Understanding quality systems in the South African prehospital emergency medical services: A multiple exploratory case study. BMJ Open Quality. 2020;9:e000946. doi:10.1136/bmjoq-2020-000946

RELATED PUBLICATION

I. **Howard I**, Cameron P, Wallis L, Castrén M, Lindström V.
Quality Indicators for evaluating prehospital emergency care: A scoping review. Prehospital and Disaster Medicine. 2019; 33(1): 43 – 52

ACKNOWLEDGEMENTS

What a journey it's been…

I would like to express my sincere gratitude and appreciation to everyone who has supported me through this journey. Special thanks go to:

- The **Department of Clinical Science and Education** at Karolinska and the **Division of Emergency Medicine** at Stellenbosch for giving me the opportunity to pursue my PhD through your departments
- **Veronica Lindström** for your constant and unwavering support. In my limited, albeit varied experience in dealing with supervisors, you are the epitome of everything that a supervisor should be. I mean it in every sense when I say that I could not have completed this PhD without you. You provided motivation and a level head whenever I needed it most. There's always a glass of wine with your name on it, wherever I am in the future
- **Lee Wallis** for first offering me this opportunity years ago, and in doing so showing your will and patience to put up with me for another couple of years after seeing me through my Master's degree
- **Peter Cameron** for your support, guidance and insight throughout this time
- **Maaret Castrén** for you support and guidance throughout this time
- **Nicholas Castle** for your patience and support, and for giving me the space that I needed when I needed it most
- All the participants for their time, attention and input
- Mom and Lucas. Thank you for everything you sacrificed, everything you struggled through and everything you provided me to make me who I am today
- Lastly but not least, Louisa. You were with me at the start, and I'm grateful to say you're with me at the end. I don't think you were quite aware what you signed up for, but you persevered, and I can't thank you enough for your support and patience, and for sharing this journey with me +=+=

CONTENTS

LIST OF FIGURES AND TABLES

Figures

Tables

LIST OF ABBREVIATIONS

ALS	Advanced Life Support
CPG	Clinical Practice Guideline
CQI	Continuous Quality Improvement
ECP	Emergency Care Practitioner
EMS	Emergency Medical Services
EMSOP	Emergency Medical Service Outcomes Projects
HPCSA	Health Professions Council of South Africa
GDP	Gross domestic product
IHI	Institute for Healthcare Improvement
IRR	Inter-rater reliability
JCAHO	Joint Commission on Accreditation of Healthcare Organizations
KAP	Knowledge, Attitude and Practices
KZN	KwaZulu Natal
LMICs	Low to middle income country setting
LP	Limpopo province
NHTSA	National Association of EMS Physicians, and the National Highway Traffic Safety Administration
NW	North West province
PBEC	Professional Board for Emergency Care
PEC	Prehospital Emergency Care
QI	Quality indicator
SA	South Africa
SAQA	South African Qualifications Authority
UK	United Kingdom
UN	United Nations
VAS	Visual analogue scale
VF	Ventricular fibrillation
WC	Western Cape
WHO	World Health Organisation

1 INTRODUCTION

Over the last three decades, the release of several landmark reports has brought the issue of patient safety and quality of care to the forefront of healthcare. The latent nature of poor quality and safety, along with the growing body of evidence that suggests when mismanaged, costs hundreds of thousands of lives and billions of dollars, has dictated that these concepts become top priorities within healthcare[1–6]. Measuring quality and safety in any healthcare setting, however, is highly contextual, and depends on the manner in which quality is defined or viewed within that setting[3,4,7,8]. It is this contextual nature that has provoked significant debate and hindered efforts at developing formal standards or criteria for measuring quality and safety in healthcare, regardless of setting[5–11].

Traditionally, quality and performance within the Emergency Medical Services (EMS) delivering prehospital emergency care (PEC) has been measured primarily on response times. The roots of this can be traced back to research conducted during the late 1970's that highlighted the benefits offered by reduced response time in cardiac arrest management[12]. The significance of these observed benefits was subsequently extrapolated to all aspects of PEC, and as a result, response time targets became the predominant measure of performance in EMS. However, response time targets address only one single aspect of the concept of patient access and fail to take into account other important time intervals, such as scene time. Furthermore, such a measure fails completely to gauge the concept of effectiveness of patient care and patient safety.

2 BACKGROUND

The field of PEC has seen considerable growth over the last two decades. The scope of practice within EMS is continuously expanding, with these services adopting new roles amongst the community[13–17]. The utilisation of EMS for patients not historically viewed as "traditional" emergencies, such as mental health, primary health care or planned patient care has increased significantly over the last two decades[13–17]. This rapid development has dictated that novel, more appropriate measures of quality and safety be implemented to compliment this growth, and ultimately improve these services overall. Internationally, significant steps have been made towards defining appropriate quality measures for PEC. However, the majority of this research remains restricted to measures of service access[18–20].

While some effort has been made towards clinical-based measures of care, this research has occurred largely within the confines of the developed systems of North America, Europe and Australia[18–22]. Little progress has been made within the low to middle income country setting (LMICs). Furthermore, healthcare expenditure and availability, service access, resource utilisation, and healthcare education within the LMICs are significantly varied in comparison to the high-income-country context[23,24]. Much of the early progress achieved in developing quality measures for PEC cannot be routinely applied or extrapolated to the LMICs. Circumstances unique to these environments need to be considered in order for appropriate measures to be defined and implemented. Understanding practitioner and system-focused factors are primary examples of how components of a particular setting or circumstance can be incorporated into the development of a bespoke quality system or framework of measurement.

2.1 EMERGENCY CARE SYSTEMS IN THE LOW TO MIDDLE INCOME COUNTRY SETTING

Within healthcare, the expanded field of emergency care (inhospital and prehospital) has a core focus on reducing preventable mortality, morbidity and disability from time-sensitive disease processes[25–28]. These are ultimately achieved through integrated systems for accessing emergency care, providing emergency care in the community, care during transportation, and care on arrival at receiving facilities[25–28]. Historically, within the LMICs however, emergency care has been prioritized lower than primary prevention-focused strategies, due to the perception that the implementation and delivery of emergency care systems are costly and benefit relatively few patients. This has been reinforced by the burden of diseases prevalent throughout these regions which have traditionally been controlled through the primary healthcare system i.e.: communicable/infectious diseases[29].

Despite this historical focus on primary care and communicable diseases, the burden has begun to shift towards an increasing prevalence of acute illness, non-communicable diseases and injuries in the LMIC setting[25–28]. The scope for improvement is therefore substantial. However, if improvements to emergency care in the LMICs can be achieved,

the outcomes are likely to be equally as significant. Approximately 45% of deaths and 36% of all disability-adjusted life years in the LMICs are amenable to secondary prevention via inhospital and prehospital emergency services[30,31]. It is estimated that strengthening trauma and emergency care in the LMICs could result in a decreased injury mortality rate of 8% (more than 400,000 lives) and cost less than $100 per disability-adjusted life year averted[32–34].

Unfortunately, this is hampered by the fact that the LMICs have consistently maintained the worst levels of healthcare access and quality indices for the last three decades[35,36]. While gains have been made regarding the historical burden felt in these regions, there has been little progress regarding the emerging threat from acute illness, non-communicable diseases and injuries[35,36]. In order to achieve improvements in the outcomes of emergency care in the LMICs, advances in quality and performance are needed over and above progress in patient access alone. Towards this, the World Health Organization (WHO) has proposed six recommendations to improve the measurement of quality of care and its impact on improving health outcomes the LMICs[37] (Table 1).

Table 1: WHO recommendations to improve quality of care in the low to middle income country setting

Recommendations for improving data collection methods and instruments	1. Redouble efforts to improve and institutionalize civil registration and vital statistics systems
	2. Reform facility surveys and strengthen routine health information systems. Routine information systems can be used to track quality over time and to evaluate improvement efforts
	3. Innovate new quality-of-care measures for low-resource contexts. Development and validation of new measures and new measurement technologies are needed
Recommendation for expanding the scope of measurements	4. Get the patient perspective on quality
Recommendations for translating the data for policy impact	5. Invest in national quality-of-care data. Rigorous collection of quality-of-care data must move beyond individual projects and facilities to the entire health system
	6. Translate quality evidence for policy impact. Robust and meaningful data presented in intuitive ways will greatly improve policy uptake of quality data

2.2 SOUTH AFRICAN EMS CONTEXT

South Africa (SA) is a country that lies at the southern tip of Africa with a population of approximately 60 million people and is considered a developing economy by the United Nations (UN), and upper middle-income country by the World Bank[38–40] (Figure 1). Total healthcare expenditure is approximately 9% of the national growth domestic product (GDP) and is primary delivered and administered regionally by one of the nine provincial governments that make up the next administrative level of government[38–40].

PEC in SA is primarily delivered by government- and private-run EMS and is based on a three-tiered system of Basic, Intermediate and Advanced Life Support levels of qualification[41–43]. Each level is licenced for independent practice and governed by a national

registration board, the Professional Board for Emergency Care (PBEC) of the Health Professions Council of South Africa (HPCSA)[41–43]. There is an increasing scope of practice between each level with Advanced Life Support (ALS) practitioners, the highest level, employing a multitude of skills analogous to Advanced Trauma Life Support and Advanced Cardiac Life Support[41–43].

Recent efforts by the PBEC have signified a desire to professionalise training and qualification within EMS in SA, following the introduction of two university based and South African Qualifications Authority (SAQA) accredited qualifications[44]. Furthermore, recent Department of Health policy reviews have highlighted the importance of systems for developing, implementing and monitoring the quality of healthcare in the country[45,46]. While significant advances have been made in improving the scope of practice of EMS, and training and education of PEC clinicians, little has been done towards ensuring the delivery of high-quality clinical care beyond the traditional response time access targets currently in use. In order to transition to a consistent high-quality, high-performance system, it is essential that measures aimed at monitoring and guiding quality improvement in EMS, are developed and implemented for the local context.

Figure 1: South African context

2.3 DEFINING AND MEASURING QUALITY IN HEALTHCARE

2.3.1 Defining Quality in Healthcare

Defining quality lies at the heart of, and guides, every initiative aimed at measuring and improving it[7,10,47]. The challenge to this, however, is in encompassing the multitude of characteristics that make up such an abstract concept like healthcare quality. Furthermore, multiple definitions of quality are possible, depending on the perspective from which it is viewed[7,48–51]. It is this contextual nature that is primarily responsible for the difficulties in outlining a single unified definition of healthcare quality, a topic that has been the focus of much debate[52]. Three overarching perspectives have been described in the literature in an attempt to define quality:

- The Provider perspective: Donabedian defined two primary components within the provider perspective that dictate how quality is perceived, namely, technical performance and interpersonal relationships. Technical performance is the requisite skills and knowledge used by a provider in order to deliver appropriate care. The interpersonal relationship component, however, lies at the patient-provider interface and encompasses the providers ability to communicate with a patient and the general manner in which information is exchanged[48,49]. McGlynns' interpretation expanded on this by contending that providers face three, often competing, influences on their view of quality that include: clinical judgement, patient values and the need to limit costs[53]. Appropriate infrastructure in the form of clinical information systems, and adequately skilled staff resources to facilitate high quality care have been described as important factors that influence the provider-based perspective[54,55].
- The Patient (and Population) perspective: Understanding the patient's perspective is arguably the most complex to define and understand. There are a multitude of potential societal and cultural factors that could influence an individual's perception of healthcare quality[56]. Of most importance is the perception that the care they seek is responsive to their individual needs[53]. Whereas technical performance is favoured by providers, patients often lack the knowledge to evaluate their own care and are possibly ambivalent towards these technical aspects[57,58]. Patients instead value the manner in which care is provided, or the competence with which it is delivered, concepts shared with the provider perspective in the form of "interpersonal relationship" [47–49,59]. This is arguably based on the assumption that high quality care is assumed and expected to be provided without limitation of cost or resource[60,61]
- The "Purchaser" perspective: Encompassing provider and patient perspectives, is the impact of economic cost, and the notion that cost and quality are confounded. Donabedian proposed two competing views – a "Maximalist" approach seeks the highest quality of care that can be achieved, represented by the greatest improvements in health, while ignoring cost[48,49]. The "Optimalist" approach alternatively considers the impact of cost and will evaluate the cost vs. benefit ratio of maximizing healthcare and the corresponding impact on quality and improvement this will bring about[48,49]

No literature could be identified that specifically defines PEC quality. However, it is arguable that defining quality care in this setting should be no different to the core components of traditional definitions of healthcare quality, and that empowerment, process, service and organizational culture are essential attributes towards maintaining high quality of PEC delivery[62,63]. Examination of the broader quality-orientated literature in the PEC context, however, reveals several themes that can be aggregated into two overarching concepts that aid in defining PEC quality – that of access and effectiveness/effective care[47].

2.3.2 Measuring Quality in Healthcare

The measurement of healthcare quality involves the review of healthcare data against defined criteria (both implicit and explicit) with the aim of assessing the quality of care provided[64]. As with defining healthcare quality, there are multiple "users" or "audiences" for the measurement and aggregation of healthcare data, including similarly, providers, patients, purchasers, managers, regulatory bodies etc.[65,66]. The healthcare data used, should therefore be selected primarily based on availability, the criteria to employed for assessment, and the audience. Similarly, for any measurement system to be successful, it is fundamental that it be comprehensive in its approach, yet simple in its design, and contextually relevant in order to provide an appropriate measure of quality.

While Donabedian attempted to define the "scope" of what one should consider when conceptually defining quality, he at the same time understood the need for a pragmatic approach towards its definition as well. It was based on this need that Donabedian proposed his seminal classification of healthcare information/data, from which inferences on quality and safety could be drawn regarding a specific healthcare system or context. He classified information into one of three categories of measures, each of which offer a distinct yet relational assessment of a healthcare system, namely: structure measures, process measures and outcome measures[48,49]:

- Structure measures denote the attributes of the setting in which health care occurs, and primarily include material resources e.g., facilities, equipment, and financing), human resources, and organizational structure
- Process measures denote the steps in the actual delivery of health care i.e., what the health care provider does to maintain or improve health e.g. making a diagnosis or recommending/implementing treatment
- Outcome measures denote the effects or impact of care on the health status of patients and/or populations i.e., changes in a patient's health status that could be attributed to antecedent care

Alternatives to Donabedian's approach towards measuring quality have been described in the literature. Sheps proposed a system of measurement based around four "areas" of healthcare system appraisal[67]:

- Set standards of care: Prerequisite standards of care minimum or optimum levels of facilities, equipment, professional training, and organization

- Elements of performance: Indices intended to reflect one or more elements of performance, e.g.: Utilization rates of certain laboratory and other diagnostic procedures, by category
- Effects of care: Indices intended to measure the effects of quality of care on patient health, analogous to outcome measures such as mortality etc.
- Clinical evaluation: Scoring system assigned to patient care records based on the completeness of records, diagnostic management, treatment, and reporting, measured against prepared standards

Roemer too, described four focus points of healthcare data for quality assessment, and included[68]:

- Patient health status outcomes, e.g.: death or disability
- Estimated quality of services: A measure he equates to Donabedian's Process measure
- Quantity of Services provided: A measure of service utilization rates
- Attitude of recipients: An early surrogate of patient reported measures

Rutstein et al. took a somewhat contrasting view in attempting to define quality, one that would align more with the contemporary approach towards measuring and assessing patient safety. In his view, because there were no easily measured quantitative definitions of bad, average or good health, he proposed an alternative system focused on measuring negative indices of healthcare, such as unnecessary disabilities, diseases and untimely deaths. Such occurrences are adverse health events that justify the careful and scientifically controlled search for underlying causes, the basis of which offer the best opportunity for improvement[69].

Despite the existence of the alternatives highlighted above, Donabedian's model has been widely accepted as the model of choice for measuring quality across healthcare in general[47,70,71]. Beyond its simplicity, one of the benefits of Donabedian's model is that while each measure classification can be viewed as independent, they inform and strengthen each other - effective structure gives rise to effective processes of care, which lead to improved patient outcomes. This has benefits from an EMS point of view, where the Donabedian approach lends itself to use for assessing PEC quality, as the care delivered in this context is largely symptomatic and/or based around specific interventions. For example, there is a significant volume of evidence that early defibrillation in patients with ventricular fibrillation (VF) (a process-based measure) improves survival (an outcome measure). Furthermore, while the availability of a defibrillator (a structural based measure) does not ensure its use, the act of delivering the process (i.e. defibrillation) would not be possible without one.

2.4 QUALITY ASSESSMENT IN EMS

Historically, several methods aimed at the formal monitoring and assessment of quality and performance within EMS have been described. These have generally fallen into one of two

distinct categories – direct observation and/or the retrospective audit of patient care records[72].

Direct observation employs the use of trained observers to monitor and assess quality and performance in real time. It allows for the on-site consultation and feedback between clinician and assessor to reinforce good practice, remediate poor practice when it occurs, and to set education goals based on these assessments[73,74]. Furthermore, it has been argued that direct observation can act as a potential safeguard against poor practice thus preserving patient safety[75]. Direct observation has been employed with multiple endpoints, including as part of new employee/trainee induction; ongoing training; and more importantly, as part of continued quality assurance processes[73–75]. Direct observation has the added benefit of offering multiple points of view as part of the observation, including peer clinicians; supervisory clinicians; receiving hospital staff; patients and patient family members[76]. Despite these described benefits, direct observation has been widely acknowledged to be significantly resource intensive, the reason often cited as the primary limitation to the widespread use of this approach[73–76].

Retrospective audit encompasses a multitude of methodologies that involve the use of objective explicit and/or subjective implicit criteria to review and assess quality of care. This is primarily conducted using patient care records and/or documents produced following patient care such complaint reports, incidents reports, and root cause analyses etc.[75,77]. As with direct observation, the possibility of multiple viewpoints can be introduced into retrospective audit through either the criteria used for assessment and/or based on the individual conducting the audit, which could similarly include peer clinicians; supervisory clinicians; and receiving hospital staff. Assessment of patient reported outcomes offer equal advantage in providing a patient and/or family-centred view of the care received. Records may be manual or electronic and likewise be assessed manually or electronically. As a small subset of retrospective audit, evaluation of audio and/or visual footage for the purpose of quality assessment has too been described[78].

The development of formal systems aimed at monitoring and improving quality within PEC has been ad hoc and slow. Much of the early development on measuring quality and safety originated in the United States, through the efforts of several professional and accreditation bodies[20,79–81]. The Joint Commission on Accreditation of Healthcare Organizations (JCAHO), American College of Emergency Physicians, National Association of EMS Physicians, and the National Highway Traffic Safety Administration (NHTSA) were all early adopters who advocated for the adaptation of Continuous Quality Improvement (CQI) to the EMS context in the early 1990s, when the concept started to gain traction and popularity within healthcare in the United States[75,79]. By the mid 1990s, to capitalize on this growing momentum towards measuring and improving PEC, the NHTSA funded a 5-year project to develop a foundation and framework for use in EMS[18,19,82,83]. The primary objective of the Emergency Medical Service Outcomes Projects (EMSOP) were to identify[18,19,82,83]:

1) Conditions that should take precedence in EMS outcomes research

2) Risk adjustment measures for these priority conditions
3) Outcome measures for these priority conditions

In EMSOP I, Maio et al. argued for the use of "tracer" conditions – those with high frequency and high potential to benefit from emergency care as a measure of EMS "effectiveness" and to guide improvement activities. Towards this, the authors identified "relief of discomfort" as the measure with the greatest potential benefit for improvement in the EMS context[18]. In EMSOP II, Spaite et al. further developed the "Episodes of Care" methodological framework for developing risk adjusted outcome measures based on severity and therapeutic time dependency for a particular condition[19]. The Out of Hospital Unit of Service framework was further developed for outcome analysis in less time critical conditions, which are better modelled by defining and measuring delivery of discrete "units of service," such as pain relief and patient satisfaction. EMSOP III further expanded on risk adjustment measures and outcome measures for potential use, with EMOP IV focusing specifically on prehospital specific measures for pain assessment and relief[82,83]. Keim et al. later used the frameworks and methodologies developed throughout the EMSOPs to develop a range of risk adjustment measures and outcome measures for out-of-hospital respiratory distress[84].

Greenberg et al. opted for a different stance to the EMSOPs and focused on the perspective of emergency care practitioners in the development of EMS specific measures of quality. These included a range of structural indicators such as the quality of training, timeliness of care and availability of resources; and a range of outcome measures such as change in complaint activity, patient outcome, and symptomatic improvement. In contrast to the EMSOP outcomes, few process-based measures of care were included in Greenberg's framework[85].

The International Association of Fire Fighters/Chiefs, based in the United States, continued the strong involvement of professional bodies in driving change through their development of a series of performance indicators for fire-based prehospital care systems. These included structural indicators such as staffing, road structure coverage, the availability of defibrillation and extrication capability and the presence of a multi-casualty plan. Process indicators such as compliance with patient care protocols were additionally included (dichotomous compliant/non-compliant with written protocol), as were outcome measures such as patient outcome at the end of EMS transportation (simple categorization of improved, remained unchanged, worsened), and user satisfaction were included[81].

There is limited evidence regarding the development of systems for the assessment of prehospital care quality outside of the United States[86]. Furthermore, the appropriateness of research conducted in one setting and its applicability to another is somewhat unclear. While research has shown that quality measures developed for one setting were useful when developing new measures for a separate setting, international variation in clinical practice and health system organization may mean that direct transfer of indicators will not always be appropriate[87].

Krafft et al. and Fisher et al. reported on their attempts at comparing the performance of multiple European EMS systems[88–90]. However, the scope of these projects was limited to a few structure based measures of care in attempt to ensure comparability across systems[88–90]. In the United Kingdom (UK), Siriwardena successfully developed and pilot-tested a series of structure- and process-based measures of clinical quality for use in English EMS, centred on five common clinical presentations including Stroke, Myocardial Infarction, Cardiac Arrest, Asthma and Hypoglycaemia[22]. He went on to further demonstrate significant improvements in quality of care delivered across twelve publicly funded ambulance service trusts in the UK, following implementation and improvement initiatives centred on the Stroke and Myocardial Infarction measures of quality previously developed[91]. In Australia, O 'Meara highlighted the need for further development and expansion beyond the eight indicators suggested by the Steering Committee for the Review of Commonwealth/State EMS Provision[92]. Of these measures, three focused on cost and expenditure, three on resource use and response times, a single generic "patient satisfaction: measure, and one outcome based, clinically focused measure on survival rate of out of hospital cardiac arrest[92].

There is an inherent lack of reporting on quality assessment in EMS in the LMICs. A single study by Rahman et al. was found that compared EMS across several Asian cities, albeit including both the High-Income Country setting and LMICs[93]. They compared and reported on a total of 14 structure-based measures, seven process measures, and five outcome measures (all of which pertained to cardiac arrest)[93]. No English language published scientific literature focused on the assessment of EMS quality in Africa could be identified[86].

3 AIMS

The overall aim of the research was to develop a framework for clinical quality and performance-based assessment of prehospital emergency care for use in the South African Emergency Medical Services. The research was divided amongst four studies, with each study constituting one of the overall research objectives (Figure 2):

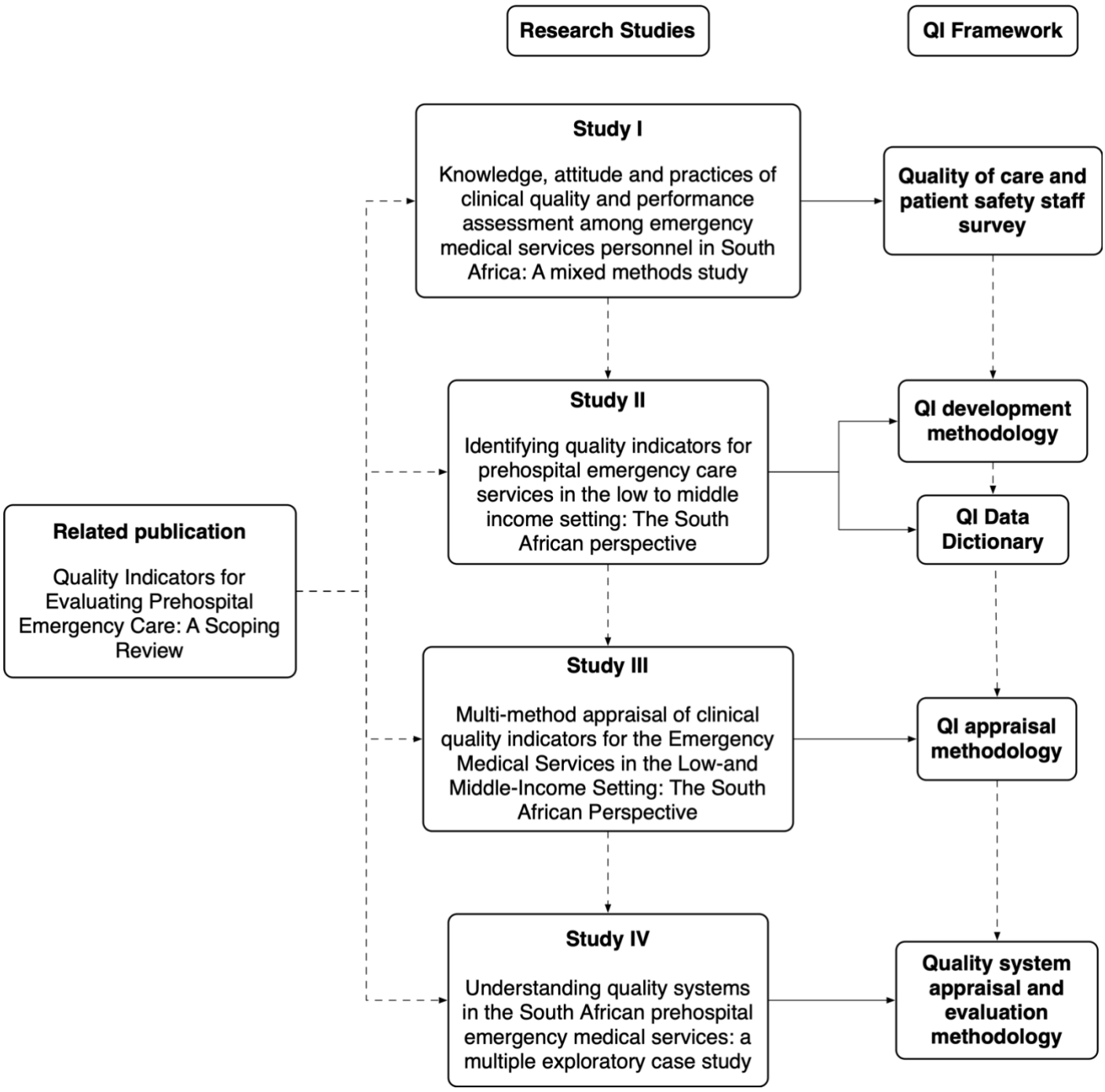
To understand the knowledge, attitudes and practices of clinical quality and performance assessment amongst South African Emergency Medical Services personnel **(Study I)**

To identify appropriate clinical quality and performance-based measures of prehospital care are for use within the South African Emergency Medical Services setting **(Study II)**

To appraise the clinical quality and performance-based measures of prehospital care for use within the South African Emergency Medical Services setting **(Study III)**

To evaluate the current state of quality systems in the South African Emergency Medical Services **(Study IV)**

Figure 2: Research studies and corresponding Quality Indicator (QI) development framework



4 METHODS

A multi-method approach was used to develop the framework for clinical quality and performance-based assessment of PEC for use in the South African EMS. However, due to the lack of literature regarding quality and performance assessment in either the SA or the expanded LMIC setting, a scoping review was conducted prior to the four studies included in the thesis. A general overview of the methodological approach utilised for the included studies is displayed in Table 2.

Table 2: Methodological overview

Study	Design	Population	Data collection
I	Sequential explanatory mixed methods	South African ALS* registered with HPCSA*	Part 1: Online survey
			Part 2: One-on-one interviews
II	Modified Delphi	Emergency physicians, nurses & EMS* staff	3 round online QI* development consensus
III	Combination of multiple methods	South African ALS registered with HPCSA	Part 1: QI appraisal consensus
			Part 2: Literature review and evidence appraisal
			Part 3: Working group discussion and consensus
IV	Multiple exploratory case study	4 provincial EMS and 1 private EMS organisation	Part 1: EMS quality system appraisal
		EMS directors	Part 2: One-on-one interviews
			Part 3: Literature review and evidence appraisal

* **ALS**-Advanced life support; **HPCSA**-Health Professions Council of South Africa; **EMS**-Emergency Medical Services; **QI**-Quality Indicator

4.1 SCOPING REVIEW

Given the relative paucity of scientific literature regarding PEC quality and performance measurement, a systematic scoping review of the literature was conducted, with the aim understanding the development and reporting of PEC specific QIs, and to define the data components and attributes necessary for their development, interpretation and implementation[86]. The scoping review methodology was selected given its primary aim to "map" the extent, range, and nature of a particular topic, summarizing the scope of evidence in order to convey the breadth and depth of a particular field[94,95]. This methodology is of particular use in new and emerging disciplines, where the quality of evidence and methodologies applied in previous research is unknown or varied[94,95].

For the purpose of this review, a QI was defined as any measure that compared actual care against ideal criteria; or a tool used to assess quality and/or performance. Article characteristics extracted included: type of research/methodology, country of origin, year of publication, institutional academic status, source of funding, population/age demographic studied, and description of the QIs within a broader organizational quality framework or structure (defined as demonstration of how and/ or where the QIs developed in the article

reviewed aligned within a larger measurement or assessment structure in the PEC environment). Quality indicator characteristics extracted included: origin of the QI, data source for developing the QI, QI data components, and whether or not a pilot of the QI was reported[86](Appendix 1).

The outcomes from the scoping review become the foundation of the doctoral studies as a whole and served to frame the research problem and how each study contributed towards achieving the overall research aim. The review further assisted specifically to refine the final objectives of each study and formed the basis for which the primary output of the overall study could be developed.

4.2 STUDY I

4.2.1 Design & analysis

A mixed methods sequential explanatory design was used, divided into two parts: Part 1 consisted of a web-based cross-sectional survey, and Part 2 consisted of semi-structured telephonic interviews of select participants from Part 1 to explore the results of the survey (Figure 3).

Part 1

The survey tool used was developed for the purposes of this study, utilising a knowledge-attitude and practices (KAP) survey framework to guide development[96,97]. Following two rounds of development, refinement and testing, a final 60 item survey was developed, composed of closed-ended, multiple choice and visual analogue scale questions. All surveys were distributed in English and completed via a web-based survey tool. Descriptive statistics were carried out to summarise and present all survey items.

Part 2

The summarised results from the survey were used to develop a semi-structured interview guide for Part 2. For the interviews, purposeful selection of participants was conducted using a maximal variation sampling strategy to ensure the inclusion of multiple participant perspectives[98]. A combination of self-selected participants from the survey, in conjunction with recruited participants meeting demographic criteria unaccounted for in the self-selected group, were included. All interviews were conducted in English and recorded for transcription and analysis. Reflective notes were maintained during each interview, and immediately after, for verification of the interview results during analysis.

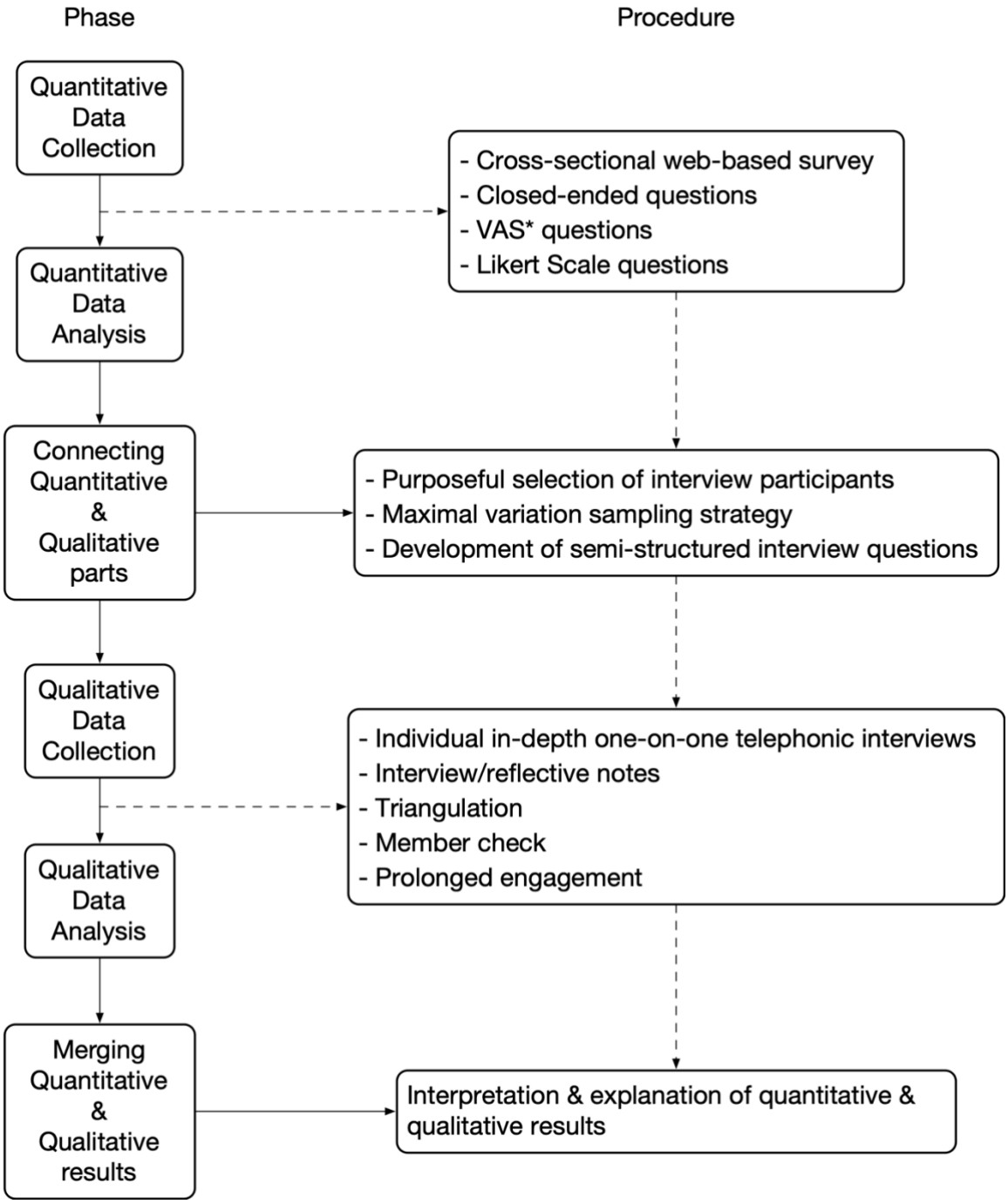
Conventional content analysis as described by Hseih and Shannon, was employed to analyse the interview data using MAXQDA software for data storage; extraction of meaning units and sub-category and category development[99,100] (MAXQDA, 2016; Sozialforschung GmbH, Berlin, Germany). First-level coding was conducted through the extraction of meaning units from each transcript and summarised into codes using open-coding from each interview. Once completed, similar codes across all interviews were combined and organised to

develop clustered sub-categories. Lastly, broad over-arching categories were identified that emerged from similar grouped sub-categories.

4.2.2 Setting & population

The target participants were SA trained EMS practitioners registered at the ALS level with the HPCSA. Practitioners from both private and government EMS and practitioners working in non-conventional EMS roles (i.e. remote site/primary care setting; education) were considered for inclusion.

Figure 3: Sequential explanatory visual model



* **VAS**-Visual analogue scale

4.3 STUDY II

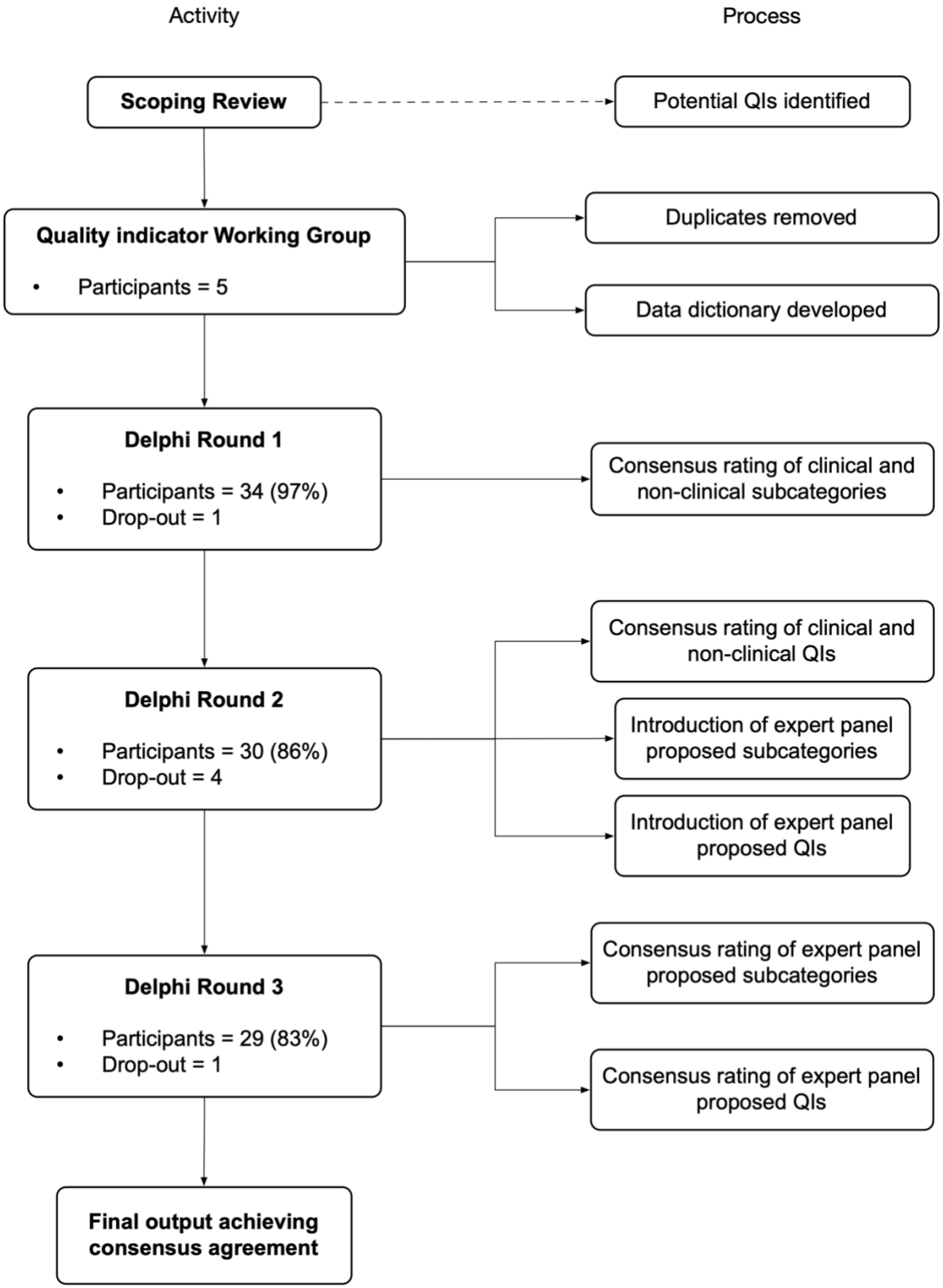
4.3.1 Design & analysis

A three-round modified online Delphi study was conducted to identify, refine and review a list of QIs for potential use in the SA PEC setting[101,102] (Figure 4). This included both the consensus agreement on the appropriateness of QIs identified in the literature, and the development of QIs amongst an expert panel. For each round, participants were required to rate their level of agreement for the respective QI subcategories and QIs based on a 5-point Likert scale, ranging from strongly disagree (1) to strongly agree (5). To achieve consensus agreement, at least 70% of participants had to rate a QI subcategory or individual QI in the "agreement" range of scores (4 or 5). QI subcategories and individual QIs that achieved consensus agreement were not reiterated in subsequent rounds. QI subcategories and individual QIs that did not reach consensus agreement, and participant proposed QIs were refined based on feedback and suggestions, and included in subsequent rounds for consensus rating.

4.3.2 Setting & population

Purposeful sampling was used to ensure appropriate experts were invited to participate due to the focus on both SA PEC and LMICs[101–103]. The range of potential participants invited included emergency medicine physicians, emergency care nurses, and PEC practitioners with a wide variety of primary occupations, including operations and clinical care, education and training, management, and quality assurance. In total, 45 participants were contacted regarding potential participation in the study. Of this group, 35 participants agreed to participate prior to the start of Round 1.

Figure 4: Delphi round progression



4.4 STUDY III

4.4.1 Design & analysis

For the purposes of this study, a QI appraisal protocol was developed consisting of two categorical-based appraisal methods, combined with the qualitative analysis of the consensus application of each method, by a QI Appraisal Working Group (Figure 5). For Round 1, the Qualify QI appraisal tool was selected given its focus on feasibility and consists of four-level Likert scale questions to assess 18 criteria amongst three categories: Relevance; Scientific Soundness and Feasibility[104,105]. For Round 3, the Rand Appropriateness Method was included due to its practical focus, as it combines the best available scientific evidence with the collective judgement of experts to yield a consensus regarding the appropriateness of medical care at the level of patient-specific symptoms, medical history, and test results[87,106,107]. The Rand method rated the indicators by testing the definitions, data components and criteria for use developed for each QI against several clinical vignettes. Four categories (Clarity, Necessity, Acceptability and Technical Feasibility) were rated using a 9-point visual analogue scale, and data extraction assessed using a mock-up of a generic patient report form for the vignettes[79,108]. Both methods consisted of an evidence evaluation component as part of the appraisal process. To achieve this, the QIs were assessed for inclusion within local clinical practice guidelines (CPGs), and against the results of a literature review of the evidence base utilised for the development of PEC focused QIs, in Round 2.

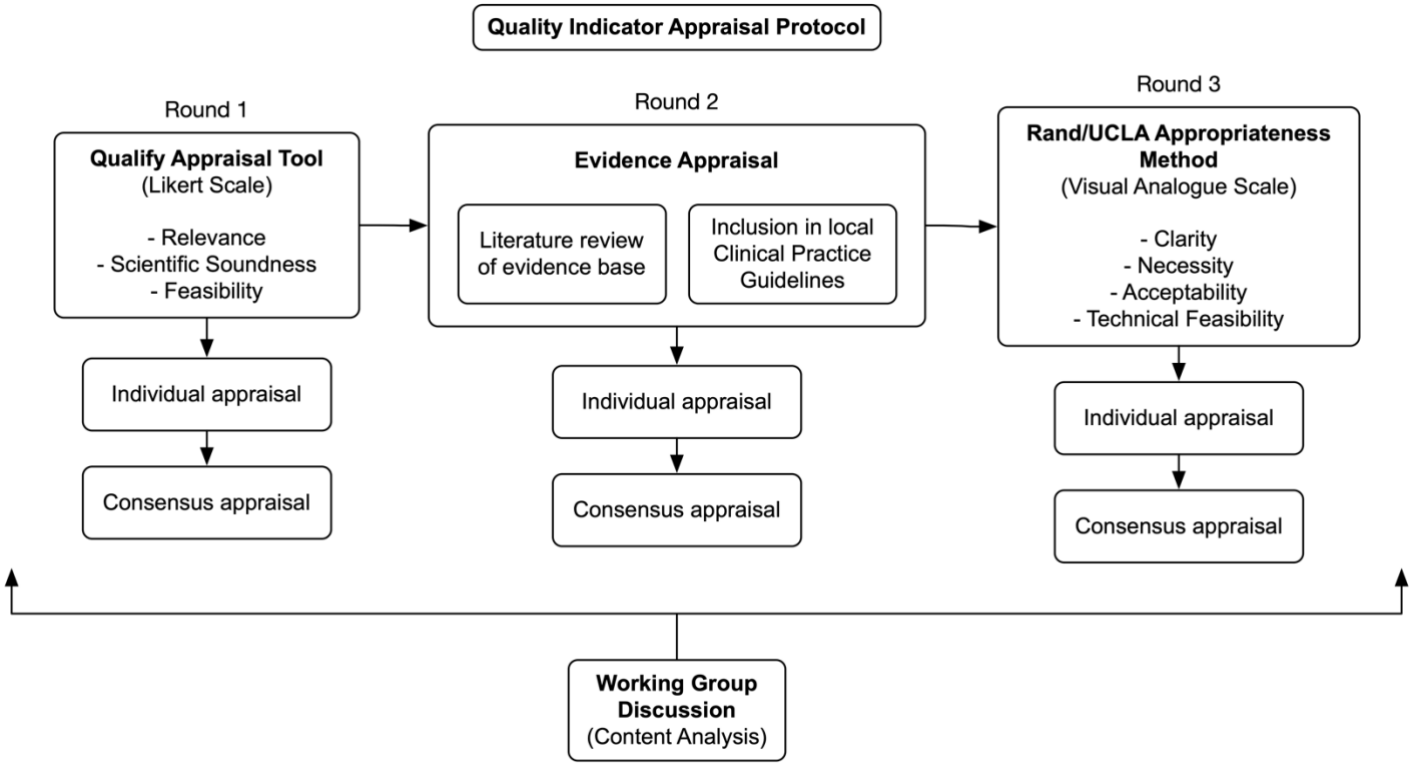
Descriptive statistics were utilised to describe and summarize the categorical based appraisal data. Inter-rater reliability (IRR) for each criterion of both the Qualify tool and Rand method were calculated using percentage agreement and Gwet's AC1 as a measure of IRR[109]. A final composite score was calculated for each QI, for each method to be considered a valid indicator. Correlation between the final composite scores was calculated using Spearman's rank correlation. The consensus derived proportion of non-valid QIs were calculated and assessed against each other using the z-test. 95% confidence intervals were calculated where necessary and a p-value of 0.05 used as a cut-off for strength of evidence. All data were entered and analysed using a combination of Microsoft Excel 2010 (Microsoft Corp., Richmond, WA, USA) and Stata version 16 (StataCorp. College Station, TX: StataCorp LLC).

Conventional content analysis, as described by Hsieh and Shannon, was utilised to analyse the group discussions generated during the three rounds[99,100]. First-level coding was conducted through the extraction of meaning units from each transcript and summarised into codes using open-coding from each interview. Once completed, similar codes were combined and organised to develop clustered sub-categories pertaining to each appraisal tool. Transcripts were analysed using MAXQDA software for data storage; extraction of meaning units and sub-category development (MAXQDA, 2016; Sozialforschung GmbH, Berlin, Germany).

4.4.2 Setting & population

The QI Appraisal Working Group consisted of nine experts chosen for their intricate knowledge of the SA PEC setting and to align with minimum panel size recommendations for each methodology[110,111]. All the participants were SA trained and post-graduate educated Emergency Care Practitioners (ECPs) with > 10 years operational experience each. Six of the participants' primary experience and occupations were in quality governance and improvement within PEC, and the remaining three were primarily involved in clinical operations. The Working Group was given one month between each round with which to work through the information and data collection required for each subsequent round.

Figure 5: Quality indicator appraisal protocol



4.5 STUDY IV

4.5.1 Design & analysis

A multiple exploratory case study design was selected as the most appropriate methodology to achieve the study aim[112,113] (Figure 6). The quality systems of four provincial government EMS and one national private EMS were utilised for the purposes of this study.

Primary data collection

The Institute for Healthcare Improvement's (IHI) Quality Program Assessment Tool was employed as the primary means of data collection (Appendix 2). The tool was used as both a formative assessment for each participating service's quality program, as well as a semi-structured interview guide to further explore the results obtained from the formative assessment. All interviews were conducted in English and recorded for transcription and analysis.

Secondary data collection

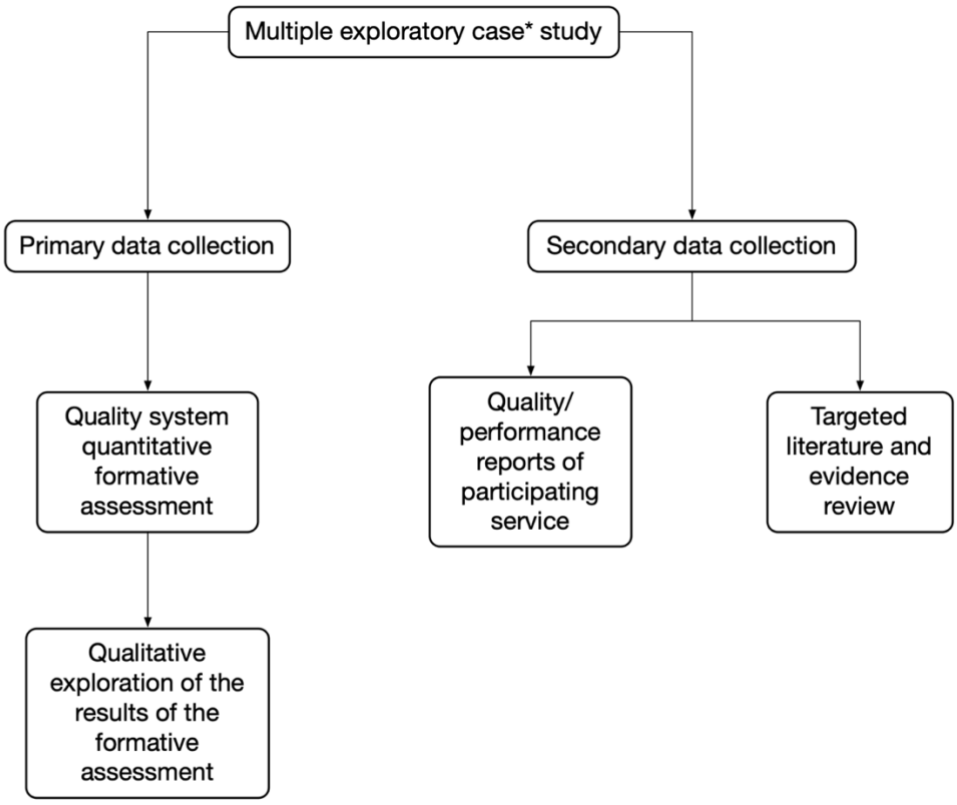
Multiple sources of secondary data were collected to support the primary data, grouped into two categories. Category A secondary data were made up of the results of a targeted literature review to identify policy-focused guidance for EMS organisations in SA regarding the implementation of a quality program; and/or the development, implementation and utilization of methods to assess quality of care. Category B secondary data were made up of publicly accessible quality and/or performance reports published by the participating services.

For the primary data collection, descriptive statistics were utilised to describe and summarize the categorical-based formative assessment. Conventional content analysis, as described by Hsieh and Shannon, was utilised to analyse the interview data[99,100]. For the secondary data collection, document analysis as described by Bowen was utilised to sort and analyse the supporting data[114]. Supporting excerpts, quotations, or passages that made reference to EMS in general or by case example were extracted and synthesized.

4.5 .2 Setting & population

Given the variations in geography and population distribution across SA, the four provincial prehospital emergency medical services of KwaZulu Natal (KZN), Western Cape (WC), Limpopo (LP) and North West (NW) provinces were purposively selected to be as inclusive of this variation as possible (Figure 7). Outcomes from Study I provided evidence to suggest that private EMS in SA are more advanced regarding the utilisation of quality assessment tools and frameworks. As a result, a national private EMS organisation was additionally included as part of the multiple case review.

Figure 6: Study IV data sources and collection



*Case definition: Quality program or system of performance measurement of a participating service

Figure 7: Provincial map of South Africa

5 ETHICAL CONSIDERATIONS

The research project conforms with the principles of the Declaration of Helsinki and abides by all the laws and regulations of the Department of Health of South Africa. The research project was approved by the Stellenbosch University Human Research Ethics Committee (HREC), reference no.: S15/09/193.

5.1 PERMISSION AND CONFIDENTIALITY

For Studies I to IV, where applicable, individual approval and written informed consent to participate was sought prior to the start of data collection. Furthermore, for Studies I and II, additional organizational permission was sought from the participating private EMS organisations. Lastly, for Study IV, approval from the participating provincial departments of health and the private EMS organisation was sought prior to data collection. Anonymity was maintained throughout the data collection process and identifying data was removed and not reported on. Further confidentiality was ensured by limiting data access to the research team.

5.2 RISKS

No direct risks were anticipated for enrolled organisations or participants. Furthermore, no participants who were considered vulnerable, or with reduced capacity were included for data collection. Discussion of the assessment of healthcare quality and performance could be considered a sensitive topic, especially when conducted with practitioners on whom such a system would be applied. It requires the acknowledgement that as healthcare workers, we are not infallible, and the potential exists for errors and adverse events to occur that may affect patients. Furthermore, discussion of and the objective assessment of organisational quality systems amongst both senior level managers and frontline workers may too be considered sensitive and potentially distressing content. To allay fears, prior to participation, potential participants were provided with detailed information regarding background to the study, the study process, expectations of the potential participant, confidentiality, ethics and contact information for the researcher and supervisors. In addition, participants were provided the opportunity to further explain and elaborate on their responses, allowing them to address any potential feelings of distress or anxiety in the content of the data collection tools and process.

6 RESULTS

6.1 STUDY I

Part 1: Knowledge, Attitude and Practices baseline cross-sectional survey

The majority of participants (73.4%) were aware that their clinical documentation underwent some form of review for quality of care, however, less than half of respondents (48.5%) were aware that these activities were performed by a dedicated quality department, or what criteria were used to assess their quality (50.9%). There was nonetheless agreement among participants regarding the desire to know: who was responsible for the review of their quality (91.1%); what criteria were used (92.9%); how quality of care was assessed (92.3%); and that these should both be made available to them (91.7%).

With regards to incentivising the results of a quality review or audit there was variation among participants, with 43.2% in disagreement and 47.9% in agreement. There was similar variation as to whether respondents felt such an incentive scheme would have a positive result on their performance. In contrast, when questioned as to whether they felt the review of a practitioner's quality should be linked to a punitive system, the majority disagreed (56.8%).

In terms of feedback and information sharing, the results of a quality review were made available to participants via a multitude of methods, with email (23.1%) and dedicated presentation days (21.3%) the most common and equally preferred (65.1% and 57.4%, respectively). Nineteen percent of participants indicated that such information was not made available to them. Approximately half (52.5%) of respondents indicated the desire to have at least monthly reporting regarding quality assessment.

Part 2: Semi-structured interviews

Overall, seven categories emerged exploring the participants' understanding of quality assessment within SA EMS and included the following (Table 3) (see Appendix 3 for supporting interview quotes):

- *General understanding of quality assessment*

A general understanding among participants was demonstrated on several levels and extended beyond just a practical focus. From a conceptual point of view, participants understood that quality assessment is a fundamental, albeit complex component of healthcare, not only within SA, but within the broader LMICs.

- *The role of context in quality assessment*

The importance of context continuously emerged as a central component, where there was widespread consensus that quality systems should be specifically designed for or tailored to setting and purpose. In terms of SA EMS, there was significant commentary regarding the variation in current systems between government and private-funded EMS, rural and urban areas and between provinces. Private services were perceived to be more advanced

regarding the utilisation of quality assessment tools and frameworks. However, there was agreement that this was largely based on a financial motivation and to a lesser extent, perceived legal ramifications if not adequately performed.

- *Factors affecting implementation*

Communication as a function of implementation was found to be essential towards achieving buy-in among staff, especially considering the desire for participants to understand the assessment process, and the importance this understanding was felt to bring in terms of participation. The historical connotations and stigma of current systems that were poorly designed and implemented emerged as a factor affecting future systems, and further emphasised the important role effective, early communication has to play.

- *Factors affecting ongoing utilisation*

Ongoing and open sharing of information, and the general inclusion of frontline staff was perceived to be a central driver towards promoting a culture aimed at prioritising quality within an organisation. Similarly, the role of management and leadership were seen as essential towards ensuring this. There was consensus among the participants that the lack of leadership input or involvement largely contributed to the poor culture, motivation and prioritisation regarding quality currently seen in the systems that exist in SA.

- *System validity and reliability*

The demonstration of an objective, transparent quality system that was consistently applied was not only key to ensuring success but was noted to be all too absent regarding systems currently employed in EMS in SA.

- *Advantages of an effective, efficient system*

Effective quality assessment was understood to be a facilitator of a multitude of factors, including training; identifying knowledge gaps; accountability and responsibility; patient safety and overall improvement.

- *Disadvantages of an inappropriate, ineffective system*

There was a general understanding of the disadvantages of an inappropriately designed or utilised quality system. It was highlighted that such systems may potentially be open to corruption, or at a more individual level, demotivate and demoralise staff, and lead to behavioural changes as a result.

Table 3: Qualitative exploration of the Knowledge, Attitude and Practices (KAP) of clinical quality and performance assessment amongst South African trained ALS EMS personnel	
Sub-category	**Category**
An essential component of healthcare (K)	General understanding of quality assessment
Used as a monitoring tool (K, P)	
Should be measured against a standard (K, P)	
Relevant to the Low Resource/Low to Middle Income Country setting (A)	
High quality care should always be expected from staff (A)	
Quality system should be tailored to local setting/take local circumstances into account (K, A)	The role of context in quality assessment
Quality system should take into account private vs. government service organisational variation (K, A)	
Quality system should take into account provincial & rural vs. urban geographical variation (K, A, P)	
Communication an essential component of implementation (A,P)	Factors affecting implementation of quality assessment systems
Historical perceptions of quality systems a barrier to implementation barrier? (A, P)	
Effective leadership has central role to play in quality system (A,P)	Factors affecting on-going utilization of quality assessment systems
Maintain open sharing of information and ideas with staff to ensure success (A, P)	
Awareness & understanding amongst staff key to buy in (A, P)	
Quality assessment should be priority within any organisation (A)	
Quality system important to public perceptions/expectations (A)	
Culture that supports staff is essential (A)	
Results of quality system should be used appropriately (A)	
Quality system should be objective & transparent (A)	Quality assessment system reliability and validity
Quality system should be consistent in its utilization & reporting (A)	
Quality system should encourage peer support (A, P)	
Effective quality system ensures patient safety (A)	Advantages of an effective, efficient quality assessment system
Effective quality system identifies knowledge gaps (A)	
Effective quality system ensures implementation of best care/evidence-based care (A)	
Effective quality system facilitates improvement in delivery & quality of clinical care (A)	
Effective quality system optimises use of available resources (A)	
Effective quality system facilitates staff & organisational responsibility & accountability (K, A)	
Inappropriate quality system open to corruption (A, P)	Disadvantages of an inappropriate, ineffective quality assessment system
Punitive based quality system leads to behavioural change in staff (A, P)	
Punitive based quality system demotivates & demoralises staff (A)	

6.2 STUDY II

The outcomes of the scoping review returned 346 QIs for potential use in the PEC setting. In addition, the review led to the development of 19 definable elements required by each QI to allow for appraisal and/or implementation (Table 4). Following the removal of duplicate and/or similarly focused indicators, a working group developed a data dictionary using these definable criteria for 202 unique QIs for evaluation by the expert panel.

Of the 202 original QIs, 104 individual QIs reached consensus agreement by the end of the Delphi study, 90 clinical QIs across 15 subcategories and 14 nonclinical QIs across two subcategories (Appendix 4). The QIs reaching consensus were broadly applicable across all three tiers of Basic, Intermediate and Advanced Life Support levels of qualification, allowing applicability across multiple settings and service types in SA. In terms of Donabedian's classification of healthcare information and data, within the final list of individual QIs, there were a total of ten (10%) structure-based QIs, 83 (80%) process-based QIs, two (2%) outcome-based QIs, and a further nine (8%) QIs categorised as adverse events, given their specific focus on patient safety.

Table 4: Data dictionary Quality Indicator (QI) components

Abbreviated Name	Abbreviated QI name
Definition	Basic description/purpose of the QI
Domain	Primary area of focus of the QI
Subdomain	Secondary area, within the Domain that the QI is focused
Clinical Pathway/Service Pathway	Identifies the Domain and Subdomain within which the QI is positioned
Measure Type	Structure, process or outcome
Target Population	Domain level population on whom the quality indicator is measured/applied
Unit of Analysis	Emergency medical service component under study/assessment for quality and performance
Numerator Statement	Description of the subset of the subdomain population on whom the quality indicator is measured/applied
Denominator Statement	Description of the subdomain level of population on whom the quality indicator is measured/applied
Case Mix/Risk Adjustment	Suggested differentiation amongst the denominator population for greater accuracy (i.e.: stratification)
Exclusion Criteria	Denominator cases to be excluded when applying the QI
Measure Calculation	The equation for calculating the QI
Numerical Reporting Format	Suggested format in which the numerical results should be reported
Graphical Reporting Format	Suggested format in which the results should be displayed/visualised
Reported Indicator	Suggested output in which results should be described
Data Source	Suggested data source to obtain the data required for calculating the QI
Suggested Reporting Period	Time frame, number of successive cases or other grouping strategies cases should be aggregated for reporting purposes
Recommended Review Period	Suggested time period at which the QI should be reviewed for validity and feasibility

6.3 STUDY III

Round 1 - QI appraisal tool

There was mixed IRR of the criteria found prior to the group consensus (Table 5). *Validity* and *Understandability & Interpretability for medical personnel* scored perfect agreement by the Working group, while *Data Collection Effort* (% agreement=22%, IRR=0.01) and *Understandability & Interpretability for patients and interested public* (% agreement=28%, IRR=0.09) and scored the lowest. Of the 104 QIs assessed, eight (7.7%) scored less than the validity threshold on the final composite score (≥3). All eight scored relatively high for *Relevance* and *Scientific Soundness* yet scored poorly for *Feasibility*. A further 15 QIs scored on the validity threshold.

Round 2 – Literature and evidence review

The evidence review found an evidence base for 11 of the 15 Clinical subcategories and the two Non-clinical subcategories, plus an additional four subcategories not included in the QI appraisal, covering 311 indicators. In excess of half (59%) were developed through a consensus/expert opinion-based approach, with fewer developed via more robust and higher quality levels of evidence such as systematic reviews and/or cohort and case control-based studies (10% each). There was however considerable representation of the QIs amongst the SA national EMS CPGs. Seventy-nine QIs (76%) were accounted for in the CPGs, of which 76 (73%) had evidence directly supporting their use (see Appendix 5 for breakdown of evidence review).

Round 3 – Rand Method

As with the appraisal tool, there was mixed IRR in the individual rating prior to the consensus rating, with *Acceptability* scoring the highest (% agreement=90%, IRR = 0.9) and *Technical Feasibility* the lowest (% agreement=47%, IRR=0.32). Eleven QIs (10.6%) scored below the validity threshold and a further eight QIs scored on the validity threshold (7.0-7.1). In total, from a series of 104 QIs, eight were identified as non-valid and three identified for which caution was recommended prior to full implementation, that were shared between the appraisal methods. A further 19 QIs were identified as non-valid and not shared by each method.

Comparison of Categorical Appraisal Methods

When final consensus validity scores were compared, there was poor to moderate correlation of the results between the Qualify tool and Rand method (Spearman's rank correlation=0.42, $p<0.001$). Ninety-two of the 104 QIs (88%) (78 clinical and 14 non-clinical) were appraised to be valid and feasible for the SA PEC setting. Of this group, an additional 21 QIs (13 clinical and eight non-clinical) were assessed to be on the threshold of validity, in which caution is recommended prior to full implementation. There was little evidence to support a statistical difference in the proportion of non-valid QIs identified between the Qualify tool and the Rand method [difference=-0.03; (95%CI -0.12:0.05, p=0.47)]; between

the Qualify tool and the protocol [difference=-0.05; (95%CI -0.13:0.03, p=0.25)]; or between the Rand method and the protocol [difference=-0.02; (95%CI -0.11:0.07, p=0.66)]. There was likewise little evidence to support a statistical difference in the proportion of QIs in which caution is recommended, identified between the Qualify tool and the Rand method [difference=0.07; (95%CI -0.02:0.15, p=0.12)]; or between the Qualify tool and the protocol [difference=-0.06; (95%CI -0.16:0.04, p=0.27)]. There was, however, strong evidence to support a statistical difference between the proportion of QIs in which caution is recommended, identified between the Rand method and the protocol [difference= -0.13; (95% CI -0.22:-0.03, p=0.009)].

Group Discussion Content Analysis

Several observations highlighted during the group discussions were found to be important considerations regarding the appraisal protocol and its ability to assess the appropriateness of the QIs. For the Qualify tool, *Relevance* and *Scientific Soundness* were perceived to be characteristics inherent to the QIs (and supporting data components) themselves, and as a result were generally appraised to be highly applicable across all QIs and criteria (Table 6). In contrast, *Feasibility* was judged to be more of a gauge of the system in which the QIs would be implemented and as such, scores were found to be on average lower amongst these criteria. Somewhat related to this, was the broader issue of context and the importance of selecting those indicators that best suited the local setting, prior to full implementation. Despite the focus on the appraisal of the QIs, on several occasions the discussion steered towards the need for EMS organisations in SA to improve their quality systems in general, if such measures are to be implemented. For the Rand method, the importance of having completed the practical data extraction using the case vignettes made a difference in the QI rating.

Table 5: Inter-rater reliability analysis of individual appraisal by the Quality Indicator Appraisal Working Group							
Methodology		% agreement [p value (95% Confidence interval)]			Kappa [p value (95% Confidence interval)]		
Quality Indicator Appraisal Tool							
Relevance							
R1	Significance	90%	[<0.001	(0.8675 – 0.9350)]	0.9	[<0.001	(0.8587 – 0.9334)]
R2	Benefit	83%	[<0.001	(0.7934 – 0.8746)]	0.82	[<0.001	(0.7704 – 0.8669)]
R3	Potential risks/side effects	41%	[<0.001	(0.3887 – 0.4395)]	0.25	[<0.001	(0.2065 – 0.2840)]
Scientific Soundness							
S1	Unambiguity of definitions	81%	[<0.001	(0.7818 – 0.8465)]	0.8	[<0.001	(0.7664 – 0.8390)]
S2	Reliability	49%	[<0.001	(0.4614 – 0.5181)]	0.3	[<0.001	(0.2647 – 0.3434)]
S3	Risk adjustment	71%	[<0.001	(0.6789 – 0.7340)]	0.66	[<0.001	(0.6248 – 0.6975)]
S4	Sensitivity	80%	[<0.001	(0.7695 – 0.8395)]	0.78	[<0.001	(0.7426 – 0.8269)]
S5	Specificity	88%	[<0.001	(0.8502 – 0.9126)]	0.87	[<0.001	(0.8395 – 0.9093)]
S6	Validity	100%		1	1		1
Feasibility							
F1	Understandability and interpretability for patients and interested public	28%	[<0.001	(0.2670 – 0.2959)]	0.09	[<0.001	(0.0646 – 0.1076)]
F2	Understandability and interpretability for medical and nursing personnel	100%		1	1		1
F3	Possibility to influence the indicator manifestation	45%	[<0.001	(0.4286 – 0.4714)]	0.35	[<0.001	(0.3233 – 0.3835)]
F4	Availability of data	65%	[<0.001	(0.6434 – 0.6630)]	0.48	[<0.001	(0.4487 – 0.5134)]
F5	Data collection effort	22%	[<0.001	(0.2104 – 0.2345)]	0.01	[<0.001	(-0.0133 – 0.0235)]
F6	Implementation barriers	49%	[<0.001	(0.4803 – 0.5069)]	0.11	[<0.001	(0.0775 – 0.1503)]
F7	Accuracy	49%	[<0.001	(0.4803 – 0.5069)]	0.11	[<0.001	(0.0775 – 0.1503)]
F8	Data integrity	49%	[<0.001	(0.4765 – 0.5030)]	0.35	[<0.001	(0.3283 – 0.3695)]
F9	Completeness of the data	49%	[<0.001	(0.4765 – 0.5030)]	0.35	[<0.001	(0.3283 – 0.3695)]
RAND method							
Clarity		85%	[<0.001	(0.8079 – 0.8854)]	0.83	[<0.001	(0.7865 – 0.8786)]
Necessity		48%	[<0.001	(0.4663 – 0.5033)]	0.39	[<0.001	(0.3663 – 0.4196)]
Acceptability		90%	[<0.001	(0.8682 – 0.9363)]	0.9	[<0.001	(0.8585 – 0.9347)]
Technical Feasibility		47%	[<0.001	(0.4401 – 0.4958)]	0.32	[<0.001	(0.2735 – 0.3568)]

Table 6: Qualitative analysis of the Working Group discussion		
Appraisal Tool	**Sub-category**	**Supporting Quote**
Qualify appraisal tool	Relevance	"For me, because practically zero clinical indicators are used or reported publicly by EMS [Emergency Medical Services] in South Africa, their relevance wand significance and benefit was naturally going to be scored high"
	Usability	"Whenever I was rating a category that I used or drew information from the data dictionary, there was always sufficient information that left no doubt that it was well planned for or accounted for. The difficult part was knowing how much variation there would be in different EMS organizations in South Africa in how they would be able to extract this information and put it to use"
	Context	"Whatever indicators are used by a service, it's important that they do a feasibility assessment of what's possible for them to achieve. We may be able to say overall, like these will work for South Africa in general, but when it comes to actual implementation, a service is going to have to understand its surroundings and the types of patients it sees"
		"Like, the indicators involving direct transport to a CT [Computed Tomography] scanner for Stroke patients, or to PCI [Percutaneous Coronary Intervention] facilities for STEMI [ST Elevation Myocardial Infarction], those will only be applicable to certain metropolitan areas, and probably only for certain private services as well. It won't be a general indicator for everyone to use"
	Quality system	"This is a complete mind shift from what we currently know and how we measure quality in South Africa. If a service is serious about implementing these, even it's just a few, they're going to have to admit that it's going to take an overhaul in their quality system, and that it's likely going to need more resources than what they dedicate to measuring response times at the moment"
		"Outside of a few of the large private services, the provincial services are going to have to ramp up the effort around measuring quality. As simple and as easy a system that these indicators are, there's probably not many of the provincial services that are ready to implement them"
RAND method	Methodology	"You really get to see how these will be used from a practical point of view. I can see the benefit of how a simple system that's objective can make the world of difference. It's not like how I used to remember it when we checked the case sheets, and it depended on how you felt at the time"
		"Doing the data extraction made a big difference, because I remember, especially for the sentinel event indicators, I scored them quite low with the appraisal tool, but when we went through them and applied them to actual cases, it was much simpler than I thought it would be and so I scored them higher after being able to actual do the extraction"
	Technology	"I think applying these indicators would be way easier with an electronic patient report form. It's going to take way more effort in doing it manually, but I can still see the benefits even if it's done this way"
	Quality system	"I think when you're sitting down and applying the indicators to case sheets, the system does seem simple and straightforward enough to use. But what do you do from there? It's going to be a logistical challenge to get the paperwork together to do the assessment, but I feel like the bigger challenge is using the information we learn, it's just as important as getting the information"
	Transparency	"It seems like it's going to be easy to game the system. Like how I know the guys have done the things that they've written down. What sort of mechanism is there for to check that they've been truthful in their notes, especially if they now know they're being watched"
	Technology	"I think [participant] was right about the electronic record, because we can build checks and balances into that sort of thing to monitor truthfulness I suppose, also like [respondent] mentioned. That also solves the legibility issue and whether or not enough information has been written. Look at when we used the poor documentation examples, it was difficult to apply the indicators to those just because you didn't always have the right information to go on"

6.4 STUDY IV

Participating services generally scored higher for *Structure* and *Planning* (Table 7), whereas *Measurement* and *Improvement*, were found to be more dependent on the services' utilisation and perceived mandate. There was a relatively strong focus on clinical quality assessment and improvement within the private service, whereas in the provincial systems, QIs reported were exclusively restricted to call times and available vehicle resources, with little to no focus on clinical care (see Appendix 6 for supporting interview quotes).

Western Cape

The provincial service's higher points in the formative assessment were largely within *Structure* and *Planning*, where a hybrid centralised/decentralised system at the district level employed EMS staff primarily dedicated to quality assessment and monitoring. Despite this strength, it was acknowledged that a lack of higher-level leadership had had a negative impact on the program. Similarly, while a comprehensive quality plan existed, it was acknowledged to be outdated and inconsistently reviewed and/or updated. Of interest to note was the services' approach towards *Measurement* and *Improvement*, and the understanding of its mandate, where it operated as a logistics and transport service more than a medical service. As a result, it was felt that reporting on time-based measures of performance was wholly appropriate. Much of the focus on improvement activities were therefore centred around transport and improving inter-facility transport booking and operations in particular. The service acknowledged that improvements could be made in terms of staff engagement, however they felt their public engagement had improved significantly in recent years.

KwaZulu Natal

The service scored low for *Structure* in the formative assessment, compared to the other services. The decentralised approach towards measurement and evaluation made coordination difficult, a situation further exacerbated by the perceived rudimentary means with which data was captured and shared. While the service acknowledged the lack of described roles, responsibilities and accountabilities within its quality plan, the content of the plan was otherwise described as comprehensive and underwent regular evaluation and updating. The service scored highest in *Measurement*, where a strong focus was placed on continuous monitoring for trend analysis. The service scored low for staff and public engagement where it was acknowledged that while some effort was made towards this, there was still much to be improved upon.

Limpopo

The Limpopo EMS quality system scored relatively highly within the *Structure* and *Planning* categories of the formative assessment. There was a strong focus on strategic planning, where their quality system and planning were firmly entrenched into the broader provincial health structures. The importance of this relationship with the provincial health system was

emphasised as a driver for potential improvements in service quality monitoring. It was acknowledged that much could be done to improve *Quality Measurement* and *Improvement* within the service, which focused primarily on response time targets and complaints for measuring and reporting of quality and performance. The notion of relationships however was echoed in these sections, where feedback from the facilities the service interacted with were too seen as an important measure of performance. Despite the low scores for *Staff engagement and Evaluation*, these factors were acknowledged as important drivers of general service success and had been earmarked for attention in the services current strategic plan for future improvement. Similarly, technology was also earmarked as a driver of success, both for staff engagement, and community accountability as well.

North West

The NW scored low across all questions and categories in the formative assessment as the provincial government, had been placed under administration. From a managerial perspective, the extreme decentralization in which the service was structured made coordination and oversight complicated, and significantly hindered process and/or plan implementation. Coupled with this, the service found it difficult to retain high-level clinical staff, further hampering the ability to implement and sustain a clinically focused quality program. From an operations point of view, based on a recent audit, it was recognised that the province's non-personnel resources were inappropriately matched towards the needs of their daily activity. The QIs that were reported by the service were limited to time-based measures, and vehicle and staff counts. Furthermore, the service lacked their own standalone committees regarding complaints and patient safety, which were instead incorporated into broader general provincial health service committees and structures.

Private EMS

There was a strong clinical focus within the quality system of the service, with representation up to the Executive level, where much of the strategic planning was conducted within a centralised office. Despite this structural strength, the service acknowledged that there was room for improvement with regards to program *Planning* and *Evaluation* towards its quality plan. While a quality management plan existed, it was acknowledged to be outdated, and not regularly reviewed. Likewise, while several clinically focused indicators were consistently reported and discussed at a high-level, the system was acknowledged to be outdated and rudimentary, largely manually captured, and difficult to change as it was not fit for purpose. This was perceived to have had an impact on both general quality monitoring and monitoring for sustained improvement. There was, however, a relatively strong focus on quality improvement activities within the service where a robust and comprehensive process was consistently followed whenever a project was carried out. Of all the categories, *Staff and Patient engagement* were perceived to be the weakest, and an area for improvement within the service. The strengths the service enjoyed in this area were largely as a result of the services private hospital group parent company.

Table 7: Quality Program Formative Assessment						
No.	**Quality Program Assessment Tool Question**	**WC**	**KZN**	**NW**	**LP**	**Private**
Quality Structure						
A.1	Does the organization have an organizational structure in place to plan, assess and improve the quality of care?	2	1	1	3	5
A.2	Have adequate resources been committed to fully support the quality program?	4	2	0	2	4
A.3	Do the leadership support the quality program?	3	1	1	3	5
Subtotal (max = 15)		9	4	2	8	14
Quality Planning						
B.1	Does the organization have a comprehensive quality improvement/management plan?	2	3	1	3	2
B.2	Does the organization have clearly described roles and responsibilities for the quality program?	4	1	0	1	4
B.3	Does the work plan specify timelines and accountabilities for the implementation of the quality program?	4	1	0	3	3
Subtotal (max = 15)		10	5	1	7	9
Quality Measurement						
C.1	Are appropriate outcome and process quality indicators selected in the quality program?	1	3	1	1	2
C.2	Does the organization regularly measure the quality of care?	1	3	0	1	3
C.3	Are processes established to evaluate, assess and follow up on quality data?	3	3	0	2	3
Subtotal (max = 15)		5	9	1	4	8
Quality Improvement Activities						
D.1	Does the organization conduct specific quality activities and projects to improve the quality of care?	3	1	1	2	3
D.2	Are quality improvement teams formed for specific projects?	3	1	0	2	4
D.3	Are systems in place to sustain quality improvements?	3	3	0	2	2
Subtotal (max = 15)		9	5	1	6	9
Staff Involvement						
E.1	Are staff routinely educated about the program's quality program?	2	1	0	2	1
E.2	Does the organization routinely engage all levels of staff in quality program activities?	2	3	0	2	2
E.3	Are patients involved in quality-related activities?	3	0	0	2	3
Subtotal (max = 15)		7	4	0	6	6
Evaluation of Quality Program						
F.1	Is a process in place to evaluate the quality program?	3	3	0	2	1
F.2	Does the quality program integrate findings into future planning?	3	3	0	2	3
F.3	Does the program have an information/data system in place to track patient care and measure quality indicators?	2	3	0	1	3
Subtotal (max = 15)		8	9	0	5	7
Total (max = 90)		48	36	5	36	53

0 – No plan/structure/process
1 – Limited plan/structures/process in place
2 – Early implementation
3 – Full implementation
4 – Developing systematic approach to quality
5 – Full systematic approach to quality

WC – Western Cape**; KZN** – KwaZulu Natal**; NW** – North West**; LP** – Limpopo

7 DISCUSSION

Measuring the quality and performance of any healthcare service in any context, extends beyond the individual measures and indicators used in its assessment. While the framework of a quality system will always be primarily rooted in its system of measurement, there is a multitude of factors that affect the implementation and utilisation of the system of measurement. Beyond the contextual appropriateness and relevance of the indicators themselves, the manner in which they are implemented, and their output is acted upon, are equally important. As a consequence, the individuals whose quality and performance will be assessed, and the service in which such a process will be implemented have a significant role to play towards the success or failure of the quality system as a whole.

In developing our framework, we acknowledged the role and contribution of practitioner and system perspectives towards its success and included their assessment as part of our framework. This allowed us to both highlight the influence these components exert on developing a quality system, as well as gain a deeper understanding of this influence to identify the primary barriers and facilitators of success at play within each component.

7.1 PRACTITIONER PERSPECTIVE

The importance of system structure, and its understanding amongst practitioners has been previously highlighted as a factor supporting the implementation of quality systems in healthcare[115]. In Study I however there was poor knowledge of organisational-specific systems demonstrated among participants surveyed. Despite this lack of knowledge, there was a desire to improve this understanding, a notion supported during the interviews when participants demonstrated an understanding of the core attributes and characteristics of quality assessment in general.

Organisational culture, and the importance of effective and engaged leadership have too been identified as important strategic determinants for success toward efficient quality management[115,116]. In Study I, there was significant commentary that emerged through interview participants' recognition of the historical connotations and stigma surrounding previous failed or ineffective quality systems, and the barrier they represented. This association was often discussed in conjunction with the general perception that these systems were often punitive in nature, with too much focus on assigning individual blame. The notion of a 'blame-culture' has previously been identified as a factor that discourages the reporting of adverse events and near misses both in healthcare in general and EMS specifically[116,117]. Linked to this, was the importance of leadership towards developing the organisational mindset and correcting the negative stigmas. To facilitate this, communication in particular emerged as a recurring feature among several of the categories identified throughout the interviews in Study I.

From a more pragmatic focus, many of the components necessary to ensure success, reported in the literature were also identified in Study 1. Factors surrounding transparency, consistency and reproducibility were initially highlighted in the survey. Validity and reliability similarly emerged during the interviews; all points previously identified as fundamental in EMS performance measurement[81]. The emphasis on context was attributed to not only the disparities seen in private versus government-funded services, but in geographical variation as well. The need to have locally relevant and appropriate measures and standards was perceived to be a facilitator of success not only in SA, but the broader LMICs. The importance of context, both in accounting for local settings when designing systems and measures, and in sustaining their utilisation have becoming increasingly recognised as central to overall success in the LMICs[37,118–120].

7.2 SYSTEM PERSPECTIVE

Much of the organisational associated outcomes from Study I were echoed in Study IV, where it was found that a centralised approach with appropriate and engaged senior/executive level management established responsibility of the system and facilitated greater control over the direction of the system, whereas decentralisation hampered collection and reporting, and as a consequence, accountability. Similarly, the role of leadership re-emerged as a factor present in study IV as both a driver of success when incorporated, and a barrier when inadequate or unaccounted for[121–123].

The lack of a cohesive vision and mission regarding quality, and the role of leadership towards developing and driving these concepts has also been associated with organisations who consistently struggle to improve quality and were similarly lacking or poorly developed within the services assessed in this study[123]. Factors associated with infrastructure, support and capacity have too been identified as key drivers of success of quality systems in healthcare[121–123]. While structure was among the highest scored attributes of the participating services in Study IV, insufficient capacity was often identified as a weak link. The combination of leadership and capacity has been described as primary drivers of a quality culture in healthcare quality systems; another component reported as both an enabler of high-quality systems when present, and a barrier to its success when absent[121–123].

All participating services in Study IV were limited in their measurement of either adverse events, technical quality of care or patient-reported measures, with the primary focus largely centred around time-based measures. This is in contrast to the increasing focus on non-time- based measures of quality evident in the literature[86]. This limitation was widely acknowledged and partially justified around the perceived purpose of EMS and what was understood to be the mandate of these services in SA. Non-time-based measures of safety and quality have previously been used as a strong base with which focused quality improvement programmes have led to meaningful and improved patient outcomes in the

PEC setting. The lack of such measures could in part explain the generally poor results observed regarding quality improvement in Study IV.

There was little to no supporting documentation in the way of national policies and/or guidelines for EMS in either implementing quality systems, measuring quality, or reporting performance found in Study IV. Furthermore, there was a general lack of policy outlining minimum standards for EMS quality systems altogether. This was evident in the variation of the results of the quality programme assessment and further highlights the need for such guidance. To be effective in both implementation and use, it is essential that appropriate high-level guidance and minimum standards regarding quality systems be outlined, as a driver for change[9,124].

7.3 QUALITY INDICATORS FOR MEASURING QUALITY AND PERFORMANCE

Quality assessment promotes accountability to all stakeholders, including both service users and service providers. QIs represent a promising and important component within the assessment process by helping to identify and measure levels of service quality and performance. In and of themselves, QIs cannot improve quality. They effectively act as flags or alerts to identify good practice, provide comparability within and between similar services, identify opportunities for improvement, and provide direction where a more detailed investigation of standards is warranted.

PEC lends itself to assessment by QIs. This was evident in the number, variety and type of QIs reaching consensus agreement in studies III and IV. Given the short amount of time that patients are exposed to these services, outcomes are difficult to measure, making the application of process based QIs ideal for assessing quality and performance. This was evident in the output of Study III, where process-based measures of care made up the majority of QIs reaching consensus agreement. Historically, non-clinical/service-based measures have been the predominant focus for measuring and assessing PEC quality[86]. In contrast however, there was an overwhelming focus on clinical-based QIs reaching consensus in Study III. Furthermore, the majority were focused on patient subsets for which PEC has been shown to have a positive impact, such as cardiac arrest[125,126], acute coronary syndromes[127], airway management/ breathing problems[128–130] and stroke[131].

Despite the findings regarding specific QIs used in Study IV, the outcomes of Study II and III represent a significant shift away from the perceived importance and “appropriateness” of time-based measures. In countries with geographically dispersed populations (i.e., proportionally high rural population) or those with an under-resourced response capability, such as that seen not only SA, but the broader LMIC setting, time-based targets for EMS are often difficult to achieve. Similarly, the majority of the indicators reaching consensus in Study II and III were those that could be readily implemented without the need for complex data and information systems such as electronic patient care records or computer aided

dispatch systems, compared to QIs previously described for more mature, "developed" PEC systems[132].

7.4 TOWARDS APPROPRIATE CONTEXT

The simplicity and practicality of QIs as a system of quality measurement has led to their widespread adoption in healthcare[87,91,133–139]. Importantly, they align with Donabedian's conceptual framework for healthcare evaluation, predicated on the belief that an effective structure gives rise to effective processes of care, which in turn result in improved outcomes[48]. Within the PEC setting, patient exposure times are generally limited, and the delivery of care based largely around processes as opposed to outcomes. The utilisation of QIs as a measure of quality are therefore ideally suited to this environment. Despite these advantages, the implementation of inappropriate or poorly tested QIs - even in well-established quality systems - has been reported to be both time-consuming and costly to correct[87,140]. Consequently, QI appraisal has been identified as an essential step toward understanding the appropriateness of these measures for a particular healthcare field or setting, prior to full implementation. The results of Study III support these notions through the application of QI appraisal protocol against a series of QIs. Further to this, the results support the value in adopting a multi-method approach towards QI appraisal, compared to the single method approach. Our observations found the multi-method approach to be advantageous in that the methods complemented each other's strengths and compensated for each other's weaknesses.

This was additionally evident in the group discussion analysis of Study III, which in and of itself added further input towards understanding and appraising the appropriateness of the QIs that would not have otherwise been captured or understood by the categorical methods alone[141,142]. Despite these advantages, the application of the protocol required a significant investment in time and staff resources. The overall benefits of such an approach are therefore heavily dependent on the availability of these resources. This availability will likely vary significantly, depending on the quality system setting within which the protocol will be applied. As highlighted in Study IV, these "system-focused" factors therefore have the potential to exert as much influence on the validity of the QIs as the setting in which the QIs will be implemented[122,123].

Healthcare quality is an abstract concept. Consequently, there are a multitude of methods, mechanisms and approaches in which it can be measured and assessed, each of which have a number of unique factors that influence their utilisation. For the purposes of this study we focused on the technical competence aspect of quality, in developing our measurement framework. Towards this, we identified a significant number of QIs assessed to be valid and feasible for the SA PEC setting. The majority of which are centred around clinically focused processes of care, measures that are lacking in current performance assessment in EMS in SA. However, we also discovered the importance and influencing role of the individual practitioners and quality system in which the QIs will be implemented, a point highlighted

across all the methodologies and studies. Given the potential magnitude of this influence, it is of the utmost importance that any measurement framework examining technical quality, have equal in-depth understanding of these factors in order to be successful.

8 METHODOLOGICAL CONSIDERATIONS

The research project provided several unique challenges to overcome in order to achieve the overall study aim. First was the lack of scientific literature regarding quality and performance assessment in either the SA or expanded LMIC setting. Therefore, the underlying approach needed to be largely exploratory in nature, with a focus on knowledge generation. Second to this was the difficulty in researching concepts that are largely abstract, or at the very least, highly subjective and contextual.

Consequently, neither a purely quantitative nor qualitative approach was deemed sufficient in order to comprehensively explore the topic. To adequately achieve this, the project relied on the utilisation of a mixed methods approach and the benefits that integrating multiple data types, sources and viewpoints can bring towards overcoming these challenges

8.1 MIXED METHODS RESEARCH

The defining characteristics of mixed methods research are best summed up in the commonly accepted definition proposed by Tashakkori and Creswell: "*Mixed Methods Research is research in which the investigator collects and analyses data, integrates the findings, and draws inferences using both qualitative and quantitative approaches or methods in a single study or program of inquiry*"[143].

Mixed methods research is a paradigm rooted in pragmatism that allows the researcher to tackle a research problem in a more comprehensive manner and from multiple perspectives than if confined within the constraints of any individual methodology[98,143–145]. The qualitative strand allows the researcher to add a narrative and therefore context to numerical data, whereas the quantitative strand offers greater underlying precision to any qualitative narrative[98,143,144]. It essentially allows for and offers researchers the ability to utilise the strengths of one method to counter or overcome the weaknesses of another[98,143,144].

The benefits of the combination of quantitative and qualitative enquiry allow for distinct, specific questions or objectives to be investigated that ultimately contribute toward the same overall end aim or purpose. The defining hallmark of mixed methods research is therefore the integration of the different paradigms and types of evidence, and the central concepts of complementarity and meta-inference – the synthesis and interpretation of qualitative and quantitative data as a single body of evidence, as opposed to independent[98,143–145]. This notion of integration is what separates current views of mixed methods research from older perspectives in which investigators collected both forms of data but kept them separate or casually combined them rather than using systematic integrative procedures[98,143–145]. The end result is that any conclusions drawn from a mixed methods study are in a better position to provide stronger evidence in that conclusion.

Through the convergence and collaboration of findings, we allow for a more complete body of evidence to inform theory and practice.

These benefits were realised in this research project, particularly in Studies I, III and IV. Studies I and IV focused on understanding the role and potential influence of the practitioner and EMS system perspective on quality measurement in PEC. Given these general aims, it was important to gain as comprehensive an understanding as possible. In each study, the quantitative approach allowed for a baseline assessment, that could then be examined on a deeper level using qualitative enquiry. Including multiple data types allowed for every facet and viewpoint to be considered and scrutinised. Furthermore, in Study IV, the secondary data added important contextual understanding and corroboration to the outcomes of the primary data collection and analysis, further strengthening the overall conclusion of that study. In Study III, the benefits of mixed methods research were directly exploited in the development of the appraisal protocol, and serve to highlight the value of multiple data sources. In addition, adding the qualitative component proved to be particularly beneficial with the additional input that would not have otherwise been captured by the individual methods alone.

8.2 ACHIEVING VALIDITY

As with either individual paradigm, questions regarding validity are common with the utilisation of mixed methods research. Towards this, integration serves as not only a methodological process, but a key component of validity in mixed methods research. Integration is primarily achieved through one or a combination of four mechanisms that include[143,146,147]:

- *Connecting*: Occurs when one type of data links with the other through the initial sampling frame e.g.: in study with a survey and qualitative interviews, the interview participants are selected from the population of participants who responded to the survey.
- *Building*: An extension of connecting, integration through building occurs when results from one data collection procedure informs the data collection approach of the other procedure, the latter building on the former e.g.: items for inclusion in a survey are built upon previously collected qualitative data or vice versa
- *Merging*: Occurs typically after the statistical analysis of the numerical data and qualitative analysis of the textual data, when the two databases are brought together for analysis and for comparison
- *Embedding*: Occurs when quantitative and qualitative data collection and analysis are recurrently linked at multiple points

In achieving validity in mixed methods research, there is a level of subjectivity when applying the concepts of *Connecting, Building, Merging* and *Embedding*. Participant sampling strategy; the decision to emphasise either the quantitative vs qualitative component; the selection of where and/or how each component will be merged or

embedded are just a few examples of some of the questions that need to be answered before conducting a mixed methods study. While they are guided by the research aim and objectives, they are ultimately open to influence by the researcher. Consequently, there is the potential for inter-researcher variation in how these processes are applied and conducted, which therefore affects the overall validity of the research. To safeguard against this, where applicable in this research project, these process were discussed with my supervisors, so as to come to a consensus on the most appropriate manner they should be conducted towards achieving the study aim.

8.3 THE PROCESS OF TRUSTWORTHINESS

Trustworthiness in mixed methods research is a concept borrowed and expanded upon from qualitative research as a further expansion of the means and mechanisms of achieving validity[143,146–148]. As with integration, it utilises the combination of data collection and evidence types to answer a common question or achieve a common aim, and is primarily accomplished through:

- *Triangulation*: The comparison and corroboration of different methodologies towards a common amalgamated aim
- *Complementarity*: Expansion and elaboration on the results acquired from one method with the results of another method
- *Development*: Similar to the concept of *Building*, it highlights the outcomes acquired from one method to inform or further develop the other
- *Initiation*: Attempts to repeat questions and outcomes from method with the equivalent in another
- *Expansion*: Increasing the span and variety of enquiry by adopting different methods for different inquiry components

Studies I and IV relied heavily on the concepts of *Connecting*, *Building* and *Merging* towards achieving their aims and objectives. Similarly, Study III, incorporated elements of *Building* and *Merging* albeit as a part of the methodology that was developed as the outcome to the study. In terms of trustworthiness, Studies I and IV again utilised *Triangulation*, *Complementarity* and *Development* of the various data sources and types to add legitimacy to the outcomes and conclusions. Study III utilised the benefits of the concept of *Triangulation* in particular in the development of the appraisal protocol.

9 GENERAL CONCLUSION

9.1 CLINICAL IMPLICATIONS

This body of research represents amongst the first to comprehensively explore EMS quality and performance assessment not just in the SA context, but the broader LMICs as well. There are a multitude of implications of all aspects of the outcomes of this research, including:

- Increased awareness and understanding of quality systems, quality and performance measurement and the role of quality measurement towards improving the quality of patient care and safety, amongst EMS staff
- Identification of areas for improvement within the systems that implement and measure and monitor quality and performance within EMS i.e.: the quality systems
- The actual measurement and assessment of clinical care and operational performance of EMS for multiple patient types and presentations
- Benchmarking the measured quality and performance of EMS across multiple service types and locations
- Identification of areas for improvement in service delivery amongst EMS
- Allowance for greater transparency and therefore accountability of EMS delivery to both the public and EMS staff

Ultimately, the measurement of clinical quality and operational performance is the first step towards facilitating and ensuring that the patients we treat, and transport get the best care that is of the highest standard, consistently.

9.2 FUTURE RESEARCH

Measuring quality and performance of EMS delivering PEC in both SA and the LMICs is in its infancy. Consequently, the scope of potential future research is extensive. This research project focused primarily on the development of a framework of technical measures of quality and performance. However, there is a multitude of factors that affect the implementation and utilization of such a system that warrant further exploration. These vary from practitioner-associated factors that influence individual uptake and support of quality assessment, to the broad strategic system factors that affect the success and ongoing utilization of the system as a whole. In terms of the individual QIs themselves, healthcare is a dynamic field that is constantly evolving and adapting to improvements in clinical care and changes in evidence informing clinical care. As a result, there will always be equal scope for quality indicators to evolve and update as changes to clinical care itself improves and evolves.

Lastly, as alluded to, the outcomes of this research are viewed primarily from the perspective of the provider/clinician. Of equal importance, and out of the scope of this

research project, is the role of PEC specific patient reported outcomes, their development and testing; and inclusion in a system of quality and performance.

10 REFERENCES

1. Brennan TA, Leape LL, Laird NM, et al. Incidence of adverse events and negligence in hospitalized patients: R esults of the Harvard Medical Practice Study I. Qual Saf Health Care. 2004;13(2):370–6.
2. Committee on Quality of Health Care in America I of M. To err is human: building a safer health system. 2000.
3. Committee on Quality of Health Care in America (Institute of Medicine). Crossing the Quality Chasm. Crossing the Quality Chasm: A New Health System for the 21st Century. 2001.
4. National Academies of Sciences; Engineering and Medicine. Crossing the global quality chasm: Improving health care worldwide. Washington, DC: The National Academies Press; 2018.
5. Kruk ME, Gage AD, Arsenault C, et al. High-quality health systems in the Sustainable Development Goals era : time for a revolution. Lancet Glob Heal. 2018;6(November):e1196-1252.
6. World Health Organization; Organisation for Economic Co-operation and Development; and The World Bank. Delivering quality health services: A global imperative for universal health coverage. Geneva: 2018.
7. Steffen GE. Quality Medical Care. A Definition. JAMA. 1988;260(1):56–61.
8. Donabedian A. The quality of care. How can it be assessed? JAMA. 1988;260(12):1743–8.
9. Harteloh PP. The meaning of quality in health care: a conceptual analysis. Heal care Anal. 2003;11(3):259–67.
10. Harris W, Lohr K. Defining Quality of Care. Medicare. A Strategy for Quality Assurance. Washington, DC: National Academies Press; 1990.
11. Wyszewianski L. Quality of Care: Past Achievements and Future Challenges. Inquiry. 1988;25:13–22.
12. Eisenberg MS, Bergner L, Hallstrom A. Cardiac Resuscitation in the Community. JAMA. 1979;241(18):1905–7.
13. Stirling CM, O'Meara P, Pedler D, Tourle V, Walker J. Engaging rural communities in health care through a paramedic expanded scope of practice. Rural Remote Health. 2007;7(Online):1–9.
14. O'Meara PF, Tourle V, Stirling C, Walker J, Pedler D. Extending the paramedic role in rural Australia: A story of flexibility and innovation. Rural Remote Health. 2012;12(Online):1–13.
15. Woollard M. The role of the paramedic practitioner in the UK. J Emerg Prim Heal Care. 2006;4(1):1–9.
16. Cooper S, Grant J. New and emerging roles in out of hospital emergency care: a review of the international literature. Int Emerg Nurs. 2009;17(2):90–8.
17. Roggenkamp R, Andrew E, Nehme Z, Cox S, Smith K. Descriptive Analysis Of Mental Health-Related Presentations To Emergency Medical Services. Prehospital Emerg

Care. 2018;22(4):399–405.

18. Maio RF, Garrison HG, Spaite DW, et al. Emergency medical services outcomes project I (EMSOP I): prioritizing conditions for outcomes research. Ann Emerg Med. 1999;33(4):423–32.
19. Spaite DW, Maio RF, Garrison HG, et al. Emergency Medical Services Outcomes Project II (EMSOP II) Developing the Foundation and Conceptual Models for Out-of-Hospital Outcomes. Ann Emerg Med. 2001;37(6):657–63.
20. Myers JB, Slovis CM, Eckstein M, et al. Evidence-Based Performance Measures for Emergency Medical Services Systems: A Model for Expanded EMS Benchmarking. Prehospital Emerg Care. 2008;12(2):141–51.
21. MacFarlane C, Benn C a. Evaluation of emergency medical services systems: a classification to assist in determination of indicators. Emerg Med J. 2003;20(2):188–91.
22. Siriwardena AN, Shaw D, Donohoe R, Black S, Stephenson J. Development and pilot of clinical performance indicators for English ambulance services. Emerg Med J. 2010;27(4):327–31.
23. GBD 2016 Causes of Death Collaborators. Global , regional , and national age-sex specific mortality for 264 causes of death, 1980 – 2016 : a systematic analysis for the Global Burden of Disease Study 2016. Lancet. 2017;(390):1151–1120.
24. Pillay-van Wyk V, Msemburi W, Laubscher R, et al. Mortality trends and differentials in South Africa from 1997 to 2012: second National Burden of Disease Study. Lancet Glob Heal. 2016;4(9):e642–53.
25. Kirsch TD, Holliman CJ, Hirshon JM, Doezetna D. The Development of International Emergency Medicine: A Role for U.S. Emergency Physicians and Organizations. Acad Emerg Med. 1997;4:996–1001.
26. Arnold JL. International emergency medicine and the recent development of emergency medicine worldwide. Ann Emerg Med. 1999;33(1):97–103.
27. Anderson P, Petrino R, Halpern P, Tintinalli J. The globalization of emergency medicine and its importance for public health. Bull World Health Organ. 2006;84(10):835–9.
28. Razzak JA, Kellermann AL. Emergency medical care in developing countries: Is it worthwhile? Bull World Health Organ. 2002;80(11):900–5.
29. Anderson PD, Suter RE, Mulligan T, Bodiwala G, Razzak JA, Mock C. World Health Assembly Resolution 60.22 and its importance as a health care policy tool for improving emergency care access and availability globally. Ann Emerg Med. 2012;60(1):35–44.
30. Kobusingye O, Hyder A, Bishai D. Emergency Medical Services. In: Disease Control Priorities in Developing Countries. New York: Oxford University Press; p. 1261-1280.
31. Kobusingye OC, Hyder AA, Bishai D, Hicks ER, Mock C, Joshipura M. Emergency medical systems in low- and middle-income countries: Recommendations for action. Bull World Health Organ. 2005;83(8):626–31.
32. Mock C, Nguyen S, Quansah R, Arreola-Risa C, Viradia R, Joshipura M. Evaluation of trauma care capabilities in four countries using the WHO-IATSIC Guidelines for

Essential Trauma Care. World J Surg 2006;30(6):946–56.
33. Mock C, Arafat R, Chadbunchachai W, Joshipura M, Goosen J. What World Health Assembly resolution 60.22 means to those who care for the injured. World J Surg. 2008;32(8):1636–42.
34. Werner K, Risko N, Burkholder T, Munge K, Wallis L, Reynolds T. Cost–effectiveness of emergency care interventions in low and middle-income countries: A systematic review. Bull World Health Organ. 2020;98(5):341–52.
35. Barber RM, Fullman N, Sorensen RJD, et al. Healthcare Access and Quality Index based on mortality from causes amenable to personal health care in 195 countries and territories, 1990–2015: a novel analysis from the Global Burden of Disease Study 2015. Lancet. 2017;390(10091):231–66.
36. BD 2016 Healthcare Access and Quality Collaborators. Measuring performance on the Healthcare Access and Quality Index for 195 countries and territories and selected subnational locations: a systematic analysis from the Global Burden of Disease Study 2016. Lancet. 2018;391:2236–71.
37. Akachi Y, Kruk ME. Quality of care: measuring a neglected river of improved health. Bull World Health Organ. 2017;(December 2016):465–72.
38. Silver BJ. Country Classifications. Forces of Labor. 2010;204–204.
39. World Health Organization. South Africa country profile. [cited 2020 Apr 30];Available from: https://www.who.int/countries/zaf/en/
40. The World Bank. World Bank Country and Lending Groups Country Classification. 2018;Available from: https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups
41. Macfarlane C, Loggerenberg C Van, Kloeck W. International EMS systems : South Africa — past , present and future. Resuscitation. 2005;64:145–8.
42. Health Professions Council of South Africa Professional Board for Emergency Care. Advanced Life Support Practitioner Protocol. Pretoria: Government Press; 2006.
43. Professional Board for Emergency Care. Clinical Practice Guidelines. 2018;(July). Available from: https://www.hpcsa.co.za/Uploads/editor/UserFiles/downloads/emergency_care/CLINICAL_PRACTICE_GUIDELINES_PROTOCOLS_2018.pdf
44. Health Professions Council of South Africa Professional Board for Emergency Care. Guidelines for the completion of the Portfolio for Institutions wishing to offer the ECT and ECP programs. Pretoria: 2011.
45. National Department of Health. Emergency Medical Services Regualtions. Gov Gaz No 41287. 2017;Available from: http://us-cdn.creamermedia.co.za/assets/articles/attachments/72257_41287_gon1320.pdf
46. Department of Health. A policy on quality in health care for South Africa. Dep Heal Repub South Africa 2007;(April).
47. Campbell SM, Roland MO, Buetow S a. Defining quality of care. Soc Sci Med. 2000;51(11):1611–25.
48. Donabedian A. Evaluating the Quality of Medical Care. Milbank Q.

1966;44(Suppl):166–206.
49. Donabedian A. The Definition of Quality. A Conceptual Exploration. Explorations in Quality Assessment and Monitoring Volume I. The Definition of Quality and Approaches to Its Assessment. Michigan: Health Administration Press; 1980.
50. Sales A, Lurie N, Moscovice I, Goes J. Is Quality in the Eye of the Beholder? Jt Comm J Qual Improv. 1995;21:219–25.
51. Blumenthal D. Part 1: Quality of Care - What is it? NEJM. 1996;335(12):891–4.
52. Health Services Research Group. Quality of Care: 1. What Is Quality and How Can It Be Measured? Can Med Assoc J. 1992;146:2153–8.
53. McGlynn EA. Six Challenges in Measuring the Quality of Health Care. Health Aff. 1997;16:7–21.
54. Batalden P, Nelson E. Hospital Quality: Patient, Physician and Employee Judgements. Int J Health Care Qual Assur. 1990;3(4):7–17.
55. Blendon R, Schoen C, Donelan K, et al. Physicians' Views on Quality of Care: A Five-Country Comparison. Health Aff. 2001;20:233–43.
56. Brook R, McGlynn E, Shekelle P. Defining and Measuring Quality of Care: A Perspective from Us Researchers. Int J Qual Heal Care. 2000;12(281–295).
57. Kenagy J, Berwick D, Shore M. Service Quality in Health Care. J Am Med Assoc. 1999;281:661–5.
58. Calnan M, Montaner D, Horne R. How Acceptable Are Innovative Health-Care Technologies? A Survey of Public Beliefs and Attitudes in England and Wales. Soc Sci Med. 2005;60:1937–48.
59. Wensing M, Jung H, Mainz J, Olesen F, Grol R. A Systematic Review of the Literature on Patient Priorities for General Practice Care. Part 1: Description of the Research Domain. Soc Sci Med. 1998;47:1573–88.
60. Cheraghi-Sohi S, Hole AR, Mead N, et al. What patients want from primary care consultations: A discrete choice experiment to identify patients' priorities. Ann Fam Med. 2008;6(2):107–15.
61. Cheraghi-Sohi S, Bower P, Mead N, McDonald R, Whalley D, Roland M. Making sense of patient priorities: Applying discrete choice methods in primary care using "think aloud" technique. Fam Pract. 2007;24(3):276–82.
62. Pirrallo R, Forster, Swor R. Reconciling the Persuit of Excellence: Essentials of a Quality EMS Organisation. Improving Quality in EMS. Dubuque: Kendall/Hunt; 2005.
63. Kingery M. Delivery of Quality Services. Emerg Med Serv. 2005;34:109–10.
64. Brook R, McGlynn E, Cleary P. Quality of Health Care. Part 2: Measuring Quality of Care. N Engl J Med. 1996;335:966–70.
65. Mainz J. Defining and classifying clinical indicators for quality improvement. Int J Qual Heal care. 2003;15(6):523–30.
66. Mainz J. Developing evidence-based clinical indicators : a state of the art. Int Jounral Qual Healthc. 2003;15(Suppliment 1):5–12.
67. Sheps M. Approaches to the Quality of Hospital Care. Public Health Rep. 1955;70:877–86.
68. Roemer M. Evaluation of Health Service Programs and Levels of Measurement.

HSMHA Health Rep. 1971;86(9):839–48.
69. Rutstein D, Berenberg W, Chalmers T, Child C, Fishman A, Perrin E. Measuring the Quality of Medical Care. A Clinical Method. N Engl J Med. 1976;294(11):582–8.
70. Handler A, Issel M, Turnock B. A Conceptual Framework to Measure Performance of the Public Health System. Am J Public Heal. 2001;91:1235–9.
71. Shroyer A, McDonald G, Wagner B, et al. Improving Quality of Care in Cardiac Surgery: Evaluating Risk Factors, Processes of Care, Structures of Care, and Outcomes. Semin Cardiothorac Vasc Anesth. 2008;12:140–5.
72. Salerno S, Wrenn K, Slovis C. Monitoring EMS Protocol Deviations: A Useful Quality Assurance Tool. Ann Emerg Med. 1991;(20):1319–24.
73. Pons P, Dinerman N, Rosen P, Derncoeur K, Coxon K, Marlin R. The Field Instructor: Quality Control of Prehospital Care, the First Step. J Emerg Med. 1985;2:421–7.
74. Krochmal P, Moore J, Shea K, Kiessling M, Blaustein D, Schriver J. Paramedic Field Instructors: An Approach to Training the Newest Paramedics While Maintaining the Interest of the Most Successful Senior Paramedics. Prehospital Disaster Med. 1995;10:106–8.
75. Swor R. Quality Assurance in EMS Systems. Emerg Med Clin North Am. 1992;10:597–610.
76. Mocjk E, Wrenn K, Wright S, Eustis T, Slovis C. Feedback to Emergency Medical Services Providers: The Good, the Bad, and the Ignored. Prehospital Disaster Med. 1997;(12):145–8.
77. McSwain N. Controversies in Prehospital Care. Emerg Med Clin North Am. 1990;8:145–54.
78. Rottman S, Fitzgerald-Westby K. A Method for Reviewing Radio-Telemetry Paramedic Calls. Ann Emerg Med. 1981;10:36–8.
79. Dunford J, Domeier RM, Blackwell T, et al. Performance Measurements in Emergency Medical Services. Prehospital Emerg Care. 2002;6(1):107–13.
80. Sobo E, Andriese S, Stroup C, Morgan D, Kurtin P. Developing Indicators for EMS Evaluation and Quality Improvement. Jt Comm J Qual Improv .1992;27(3):138–54.
81. Moore L. Measuring Quality and Effectiveness of Prehospital EMS. Prehospital Emerg Care. 1999;3(4):325–31.
82. Garrison HG, Maio RF, Spaite DW, et al. Emergency Medical Services Outcomes Project III (EMSOP III): the role of risk adjustment in out-of-hospital outcomes research. Ann Emerg Med. 2002;40(1):79–88.
83. Maio RF, Garrison HG, Spaite DW, et al. Emergency Medical Services Outcomes Project (EMSOP) IV: Pain measurement in out-of-hospital outcomes research. Ann Emerg Med. 2002;40(2):172–9.
84. Keim SM, Spaite DW, Maio RF, et al. Establishing the scope and methodological approach to out-of-hospital outcomes and effectiveness research. Acad Emerg Med. 2004;11(10):1067–73.
85. Greenberg MD, Garrison HG, Delbridge TR, et al. Quality indicators for out-of-hospital emergency medical services: the paramedics' perspective. Prehosp Emerg Care. 1997;1(1):23–7.

86. Howard I, Cameron P, Wallis L, Castren M, Lindstrom V. Quality Indicators for Evaluating Prehospital Emergency Care: A Scoping Review. 2017;33(1):43-52.
87. Marshall Martin MN, Campbell Sue Kirk SM, Reeves D, et al. Measuring General Practice: A demonstration project to develop and test a set of primary care clinical quality indicators Professors of General Practice. 2003;Available from: www.nuffieldtrust.org.uk
88. Krafft T, Fischer M, Riesgo LG-C, Overton J. European Emergency Data Project (EED Project). Eur J Public Heal . 2003;12(3):85–90.
89. Krafft T, Garcia L, Riesgo C, Fischer M, Robertson-steel I, Lippert F. European Emergency Data Project EMS Data-based Health Surveillance System. 2002.
90. Fischer M, Kamp J, Riesgo LG, et al. Comparing emergency medical service systems — A project of the European Emergency Data (EED) Project. Resuscitation. 2011;82:285–93.
91. Siriwardena AN, Shaw D, Essam N, et al. The effect of a national quality improvement collaborative on prehospital care for acute myocardial infarction and stroke in England. Implement Sci. 2014;9(17):1–9.
92. O'Meara P. A generic performance framework for ambulance services: an Australian health services perspective. J Emerg Prim Heal Care. 2005;3(3).
93. Rahman NH, Tanaka H, Shin S Do, Ng YY, Piyasuwankul T. Emergency medical services key performance measurement in Asian cities. Int J Emerg Med. 2015;8(12):4–9.
94. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. Int J Soc Res Methodol. 2005;8(1):19–32.
95. Levac D, Colquhoun H, O'Brien KK. Scoping studies: advancing the methodology. Implement Sci. 2010;5:69.
96. World Health Organization. A guide to developing knowledge, attitude and practice surveys. 2008.
97. Kaliyaperumal K. Guideline for Conducting a Knowledge , Attitude and Practice (KAP) Study. Community Ophthalmol. 2004;4:7–9.
98. Onwuegbuzie AJ, Collins KMT. A Typology of Mixed Methods Sampling Designs in Social Science Research. 2007;12(2):281–316.
99. Hseih H-F, Shannon SE. Three Approaches to Qualitative Content Analysis. Qual Health Res. 2005;15(9):1277–88.
100. Graneheim U, Lindgren B. Methodological challenges in quialitative content analysis: A discussion paper. Nurse Educ Today. 2017;56(December):29–34.
101. Boulkedid R, Abdoul H, Loustau M, Sibony O, Alberti C. Using and Reporting the Delphi Method for Selecting Healthcare Quality Indicators: A Systematic Review. PLoS One. 2011;6(6):e20476.
102. Williams P, Webb C. The Delphi technique a methodological discussion. J Adv Nurs. 1994;(19):180–6.
103. Cole ZD, Donohoe HM, Stellefson ML. Internet-based Delphi research: Case based discussion. Environ Manage. 2013;51(3):511–23.
104. De Cruppé W, Kleudgen S, Diel F, Burgdorf F, Geraedts M. Feasibility of 48 quality indicators in ambulatory care in Germany: A cross-sectional observational study. Z

Evid Fortbild Qual Gesundhwes. 2015;109(9–10):682–94.
105. Bieler D, Hörster A, Lefering R, et al. Evaluation of new quality indicators for the TraumaRegister DGU® using the systematic QUALIFY methodology. Eur J Trauma Emerg Surg. 2018;0(0):0.
106. Santori G, Fontana I, Valente R, Ghirelli R, Valente U. Application of the RAND/UCLA Appropriateness Method to Evaluate an Information System for Kidney/Pancreas Transplantation in Adult Recipients. Transplant Proc. 2008;40(6):2021–3.
107. Bobrovitz N, Parrilla JS, Santana M, Straus SE, Stelfox HT. A qualitative analysis of a consensus process to develop quality indicators of injury care. Implement Sci. 2013;8:45.
108. Stelfox HT, Bobranska-Artiuch B, Nathens A, Straus SE. A systematic review of quality indicators for evaluating pediatric trauma care. Crit Care Med. 2010;38(4):1187–96.
109. Wongpakaran N, Wongpakaran T, Wedding D, Gwet KL. A comparison of Cohen's Kappa and Gwet's AC1 when calculating inter-rater reliability coefficients: A study conducted with personality disorder samples. BMC Med Res Methodol. 2013;13(1):1–7.
110. BQS - Institute of Quality and Patient Safety. QUALIFY: Instrument for the Assessment of Quality Indicators. 2007;(August):60.
111. Fitch K, Bernstein SJ, Aguilar MD, et al. The RAND/UCLA Appropriateness Method User's Manual. 2001.
112. Hatch AJ. Deciding to Do a Qualitative Study. Doing Qual Res Educ Settings. 2002;11(1):1–20.
113. Yin R. Case Study Research and Applications: Design and Methods. 6th ed. California: SAGE Publications;
114. Bowen GA. Document analysis as a qualitative research method. Qual Res J. 2009;9(2):27–40.
115. Wardhani V, Utarini A, van Dijk JP, Post D, Groothoff JW. Determinants of quality management systems implementation in hospitals. Health Policy. 2009;89(3):239–51.
116. Fairbanks RJ, Crittenden CN, O'Gara KG, et al. Emergency medical services provider perceptions of the nature of adverse events and near-misses in out-of-hospital care: An ethnographic view. Acad Emerg Med. 2008;15(7):633–40.
117. de Vos ML, van der Veer SN, Graafmans WC, et al. Implementing quality indicators in intensive care units: exploring barriers to and facilitators of behaviour change. Implement Sci. 2010;5:52.
118. Leatherman S, Ferris TG, Berwick D, Omaswa F, Crisp N. The role of quality improvement in strengthening health systems in developing countries. Int J Qual Health Care. 2010;22(4):237–43.
119. Bhattacharyya O, Mossman K, Ginther J, et al. Assessing health program performance in low- and middle-income countries: building a feasible, credible, and comprehensive framework. Global Health. 2015;11(1):51.
120. Kruk ME, Larson E, Twum-Danso NAY. Time for a quality revolution in global health. Lancet Glob Heal. 2016;4(9):e594–6.

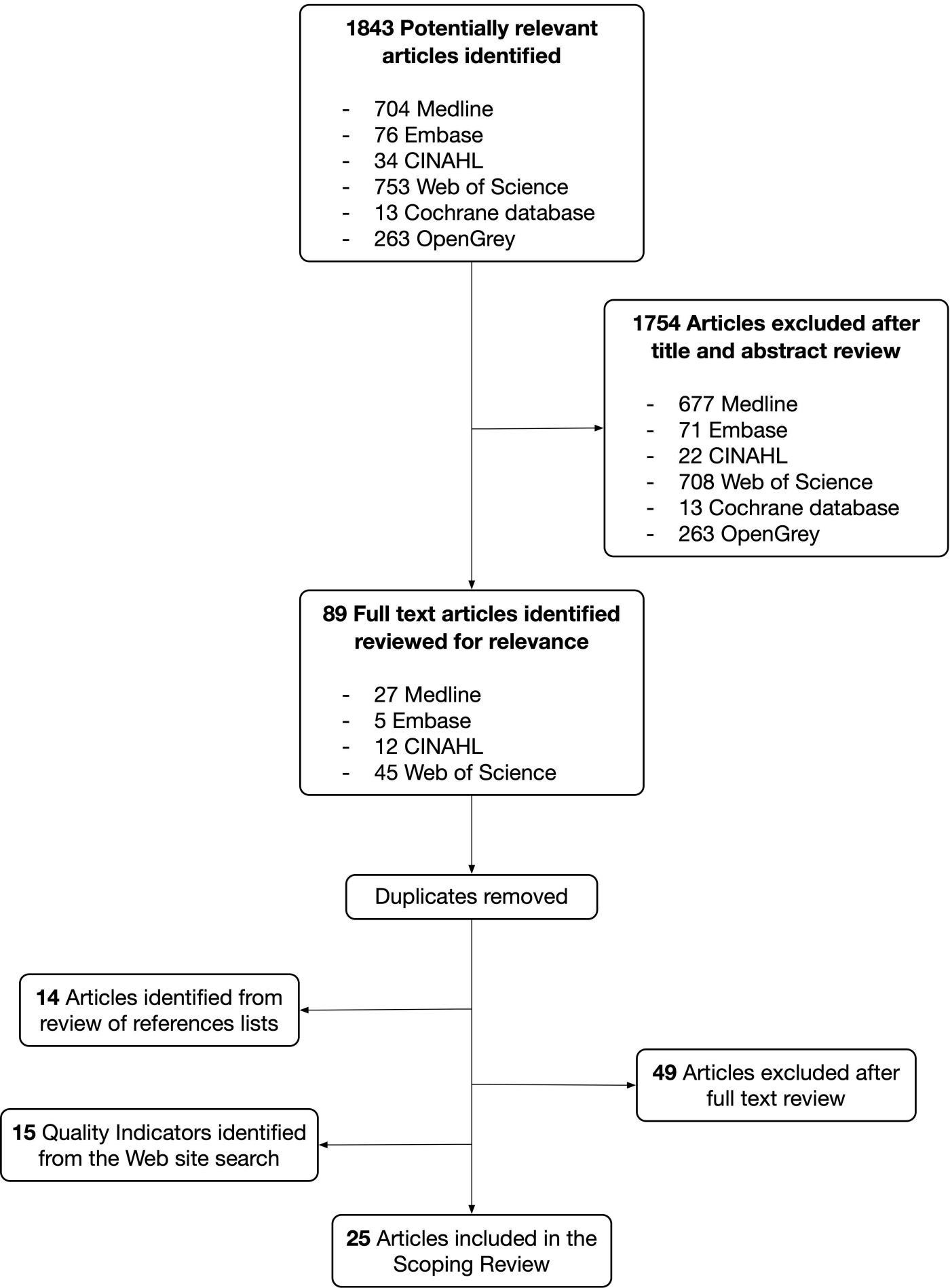
121. Øvretveit J. Understanding the conditions for improvement: Research to discover which context influences affect improvement success. BMJ Qual Saf. 2011;20(SUPPL. 1):1–6.
122. Kaplan HC, Provost LP, Froehle CM, Margolis PA. The model for understanding success in quality (MUSIQ): Building a theory of context in healthcare quality improvement. BMJ Qual Saf. 2012;21(1):13–20.
123. Vaughn VM, Saint S, Krein SL, et al. Characteristics of healthcare organisations struggling to improve quality: Results from a systematic review of qualitative studies. BMJ Qual Saf. 2019;28(1):74–84.
124. Harteloh PPM. Quality systems in health care: A sociotechnical approach. Health Policy. 2003;64(3):391–8.
125. Eisenberg MS, Bergner L, Hallstrom A. Cardiac Resuscitation in the Community. Importance of Rapid Provision and Implications for Program Planning. 2014;241(18):1905–7.
126. Perkins GD, Cooke MW. Variability in cardiac arrest survival: the NHS Ambulance Service Quality Indicators. Emerg Med J. 2012;29(1):3–5.
127. Gara PTO, Kushner FG, Ascheim DD, Casey DE, Guidelines et al on behalf of he American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. ACCF/AHA 2013 Guideline for the Management of ST-Elevation Myocardial Infarction: A Report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. Circulation. 2013;(127):e362–425.
128. British Thoracic Society Standards of Care Committee. British guideline on the management of asthma A national clinical guideline. Thorax. 2011;66(Suppl 2):i1–23.
129. Japanese Society of Anesthesiologists. JSA airway management guideline 2014: To improve the safety of induction of anesthesia. J Anesth. 2014;28(4):482–93.
130. Mebazaa A, Gheorghiade M, Piña IL, et al. Practical recommendations for prehospital and early in-hospital management of patients presenting with acute heart failure syndromes. Crit Care Med. 2009;36(Suppl):S129–39.
131. Powers WJ, Rabinstein AA, Ackerson T, et al. 2018 Guidelines for the Early Management of Patients With Acute Ischemic Stroke: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. 2018. Available from: http://www.ncbi.nlm.nih.gov/pubmed/29367334
132. Murphy A, Wakai A, Walsh C, Cummins F, O'Sullivan R. Development of key performance indicators for prehospital emergency care. Emerg Med J. 2016;33(4):286-292 7p.
133. Kollberg B, Elg M, Lindmark J. Design and implementation of a performance measurement system in Swedish health care services: a multiple case study of 6 development teams. Qual Manag Health Care. 2005;14(2):95–111.
134. Coleman P, Nicholl J. Consensus methods to identify a set of potential performance indicators for systems of emergency and urgent care. J Health Serv Res Policy. 2010;15 Suppl 2:12–8.
135. Hoogervorst EM, van Beeck EF, Goslings JC, Bezemer PD, Bierens JJLM. Developing

process guidelines for trauma care in the Netherlands for severely injured patients: results from a Delphi study. BMC Health Serv Res. 2013;13(1):79.

136. Abrams H, Belanger F, Carew D, et al. Prioritizing performance measurement for emergency department care : consensus on evidence- based quality of care indicators Steering committee. 2011;13(5):28–43.
137. Nakayama DK, Saitz EW, Gardner MJ, Kompare E, Guzik E, Rowe MI. Quality assessment in the pediatric trauma care system. J Pediatr Surg. 1989;24(2):159–62.
138. Mackenbach JP, McKee M. A comparative analysis of health policy performance in 43 European countries. Eur J Public Health. 2013;23(2):195–201.
139. Groene O, Klazinga N, Kazandjian V, Lombrail P, Bartels P. The World Health Organization Performance Assessment Tool for quality improvement in hospitals (PATH): An analysis of the pilot implementation in 37 hospitals. Int J Qual Heal Care. 2008;20(3):155–61.
140. Campbell S, Kontopantelis E, Hannon K, Burke M, Barber A, Lester H. Framework and indicator testing protocol for developing and piloting quality indicators for the UK quality and outcomes framework. BMC Fam Pract. 2011;12:85.
141. Curry LA, Nembhard IM, Bradley EH. Qualitative and mixed methods provide unique contributions to outcomes research. Circulation. 2009;119(10):1442–52.
142. Van Harten WH, Casparie TF, Fisscher OAM. Methodological considerations on the assessment of the implementation of quality management systems. Health Policy. 2000;54(3):187–200.
143. Regnault A, Willgoss T, Barbic S. Towards the use of mixed methods inquiry as best practice in health outcomes research. J Patient-Reported Outcomes. 2018;2:2–5.
144. Teddlie C, Yu F. Mixed Methods Sampling: A Typology With Examples. J Mix Methods Res. 2007;1(1):77–100.
145. Leech NL, Onwuegbuzie AJ. Guidelines for conducting and reporting mixed research in the field of counseling and beyond. J Couns Dev. 2010;88(1):61–70.
146. Fetters MD, Curry LA, Creswell JW. Achieving integration in mixed methods designs - Principles and practices. Health Serv Res. 2013;48(6):2134–56.
147. Guetterman T, Creswell J. Using joint displays and MAXQDA software to represent the results of mixed methods research. Use of visual displays in research and testing: Coding, interpreting, and reporting data. Ann Fam Med. 2015;13:554–61.
148. Guba EG. Criteria for assessing the trustworthiness of naturalistic inquiries. Educ Commun Technol. 1981;29(2):75–91.

** All images purchased from Shutterstock

Appendix 1: Scoping Review process



Appendix 2: Quality Management Program Assessment Tool

A. **Quality Structure**
B. **Quality Planning**
C. **Quality Measurement**
D. **Quality Improvement Activities**
E. **Staff Involvement**
F. **Evaluation of Quality Program**

A) Quality Structure

A.1. Does the organization have an organizational structure in place to plan, assess and improve the quality of care?					
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**
Score 0	No structure in place				
Score 1	Quality structure is only loosely in place; a few quality meetings of some staff; knowledge of quality structure is limited to only a few people in program; meetings are only used to discuss individual cases or problems.				
Score 2					
Score 3	Senior clinician/manager leads the quality committee; at least 4 quality meetings a year are held; multidisciplinary team members are represented in quality structure; routine reporting to external governing body; staff knows about quality committee meetings; minutes are kept; some links to external stakeholders.				
Score 4					
Score 5	Senior medical clinician/senior management is actively involved in quality committees; quality meetings include written minutes and written follow-up; understanding of entire staff about quality structure and reporting mechanism; active support by overall agency; strong links to external stakeholders; structured input from consumers or consumer advisory board.				

A.2. Have adequate resources been committed to fully support the quality program?					
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**
Score 0	No resources are committed.				
Score 1	Only senior clinician or designated quality coordinator is responsible to coordinate quality efforts; quality is not part of staff's job expectations; quality work is done in addition to daily work loads; little resources have been made available for information systems.				
Score 2					
Score 3	Key staff members have time allotted for quality activities; half-time position is available for quality manager; moderate resources for information systems.				
Score 4					
Score 5	Most staff members have quality in their job descriptions and expectations; Full-time position of quality manager is available; resources are committed for information systems				

A.3. Do the leadership support the quality program?					
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**
Score 0	No leadership support.				
Score 1	Program leadership reviews quality data; support for QI is not consistent and regularized; involvement is only active if needed; leadership has limited experience in QI activities; link to institution's overall quality program is only by reporting data.				
Score 2					
Score 3	Program leadership supports QI and sees quality improvement as a priority; leadership has established program commitment to quality; leadership supports staff and quality activities if needed; leadership involved in setting quality priorities; institution's overall quality program encourages interdepartmental cooperation.				
Score 4					
Score 5	Program leadership stresses being proactive; quality and patient focus are build into new programs and initiatives; program leadership advocates for QI with the rest of the organization; leadership is actively involved in ongoing education about quality; leadership uses every opportunity to promote quality improvement; quality and improvement issues are discussed at top staff meetings at overall organization.				

B) Quality Planning

B.1. Does the organization have a comprehensive quality improvement/management plan?					
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**
Score 0	No QI/QM plan in place.				
Score 1	Quality program has only a loosely outline of a structured quality plan; a written plan does not reflect current day-to-day operations; goals for the quality program are not established.				
Score 2					
Score 3	The quality plan is reviewed and updated annually; the quality plan describes the quality committee structure and its frequency of meetings; key quality principles and objectives are outlined; annual goals have been discussed and agreed on by quality committee; the quality plan is shared with staff.				
Score 4					
Score 5	The written quality infrastructure includes a multidisciplinary membership and its reporting mechanism; the link to the organization's overall quality program is described; the quality committee oversees and provides feedback to quality improvement projects; staff is aware of the plan; staff is actively involved in review and update of the quality plan; annual goals are actively communicated and understood by staff; selection and prioritization process is clearly defined; staff is actively involved in selection process.				

B.2. Does the organization have clearly described roles and responsibilities for the quality program?					
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**
Score 0	No roles are described.				
Score 1	Roles and responsibilities are not described for quality structure; staff has vague idea about involvement in quality program; no written documentation.				
Score 2					
Score 3	Key roles for quality program are clearly described; leadership and governance are				

	established; staff is informed about different roles; QI team roles are described; follow-up for quality activities are unclear.
Score 4	
Score 5	The staffs' roles and responsibilities are clearly described regarding involvement in committee structure, performance measurements, and quality activities; description of accountability is routinely reviewed and updated at least annually; staff is involved in design of roles and responsibilities; structure in place to monitor progress of quality activities.

B.3. Does the work plan specify timelines and accountabilities for the implementation of the quality program?					
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**
Score 0	No work plan exists.				
Score 1	No specific timelines and accountabilities have been established; no formal process to assign timelines for quality projects; follow-up of quality findings only as needed.				
Score 2					
Score 3	Quality activities are somewhat planned for the near future; workplan specified annual cycle of review for goal statements; quality committee is aware of timetable; findings of quality activities are routinely discussed in quality committee; staff is not assigned to be accountable for the implementation of certain quality activities.				
Score 4					
Score 5	Process to assign timelines for all quality reviews and improvement projects is clearly described; annual plan for resources is established; most of staff are aware of timelines; structure to discuss update of all quality activities at each quality committee meeting; staff members have clearly assigned roles and expectations for projects; staff are held accountable.				

C) Quality Measurement

C.1. Are appropriate outcome and process quality indicators selected in the quality program?					
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**
Score 0	No indicators are selected.				
Score 1	Only those indicators have been selected that were required; no process takes place to annually review and update indicators; selection of indicators was done by senior clinician or by quality coordinator.				
Score 2					
Score 3	Selection of indicators was based on results of internal quality initiatives and external audits; indicators have written definitions and frequencies of review; staff is aware of indicators; indicators reflect standards of care.				
Score 4					
Score 5	Annual process to update indicators; required and non-required outcome and process indicators have been selected; all indicators definitions include outcome and steps for follow-up; staff is involved in development of indicators; most staff knows indicators and their definitions.				

C.2. Does the organization regularly measure the quality of care?					
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**

Score 0	Quality of care is not measured.
Score 1	Program measures only what is required; only few staff members are involved in measurement process; no description of review process.
Score 2	
Score 3	Process in place to measure performance; performance reviews and implementation steps have defined timetables; most staff are involved in measurement process; results are reviewed in quality committee.
Score 4	
Score 5	Process to evaluate and measure performance clearly described; monthly performance reviews; quality results are regularly reviewed by the organization's leadership and action is taken on the results; staff are actively involved in measurement process; staff are trained in review process.

C.3. Are processes established to evaluate, assess and follow up on quality data?					
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**
Score 0	No process in place to follow-up on quality data.				
Score 1	Only senior leadership receives quality reports. Results are not shared with other staff routinely, unless there is a problem. Reporting of quality outcomes and results often feels punitive. Sporadic reporting of results and no process in place to respond to results.				
Score 2					
Score 3	Quality reports are shared with senior leadership team and quality committee. Periodic quality changes and interventions attempted. No consistent process to act on results; no routine follow-up on all quality data reports; some staff receive the information.				
Score 4					
Score 5	All staff receive appropriate quality reports and results. Quality results are regularly reviewed by staff and action is taken on the results; staff is actively involved in staff meetings in discussing results and proposing improvement activities; staff is trained on how to use results to initiate improvement activities and how to communicate with quality committee. Innovation, within a clearly defined quality planning process, is encouraged and rewarded.				

D) Quality Improvement Activities

D.1. Does the organization conduct specific quality activities and projects to improve the quality of care?					
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**
Score 0	No quality activities are taking place.				
Score 1	Quality improvement activities focused on individual cases without any analysis of underlying cause; reviews are primarily used for inspection/compliance; selection of project is done by single person.				
Score 2					
Score 3	A few staff members have input in selection of quality initiatives; quality improvement activities focused on processes; projects are conducted based on performance data results; findings are presented to quality committee; QI principles (consumer focus, staff involvement, teams) were applied.				
Score 4					
Score 5	Structured process of selection and prioritization; routine identification of customer needs				

	and input in quality improvements; majority of staff involved in quality improvement projects; findings are shared with entire staff.

D.2. Are quality improvement teams formed for specific projects?					
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**
Score 0	No teams are formed.				
Score 1	A group of staff meets to discuss improvements; mostly the same staff members are involved; methodologies for quality improvement teams are not used.				
Score 2					
Score 3	One or two QI teams had been introduced; basic staff knowledge about QI team; multidisciplinary team approach; QI approach is used to address quality projects; results are presented at quality committee; QI teams use established methodologies.				
Score 4					
Score 5	QI teams are used routinely to address complex quality issues; participation of most staff in QI teams; staff is trained in their team roles; team continues to monitor changes; ongoing assistance is provided by leadership; results are shared with all staff.				

D.3. Are systems in place to sustain quality improvements?					
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**
Score 0	No systems to sustain QI in place.				
Score 1	Quality improvement activities result in minimal change in delivery system; no training for staff is required; only some providers are impacted; efforts to improve the health of patients has only minimal impact; improvements are only short-term; minimal involvement by staff.				
Score 2					
Score 3	Some short and long-term benefits for some clients; process in place to continue to monitor change; some staff educated about changes; some job descriptions are altered.				
Score 4					
Score 5	Quality improvement activities result in a fundamental change of delivery system; improvements require staff to be trained; impact is measured and related to improved outcome; sustainable success for all intended clients; program demonstrated culture of support of learning and improvement; staff is actively involved in process.				

E) Staff Involvement

E.1. Is the staff routinely educated about the program's quality program?					
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**
Score 0	No staff training in place.				
Score 1	Only a few people have access to training opportunities; one or two journals or books are available about quality; no additional resources for quality training are available.				
Score 2					
Score 3	No formal process in place to train all staff routinely about quality principles; some staff members can attend external quality training; some staff can order books and journals about quality.				
Score 4					
Score 5	Almost all staff members attend an annual quality training; staff knows about QI				

	principles; quality articles are routinely shared and forwarded among staff; many journals and books are available for staff; content of quality conferences and recent developments are routinely communicated among staff.

E.2. Does the organization routinely engage all levels of staff in quality program activities?					
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**
Score 0	No involvement of different staff levels.				
Score 1	Results of quality activities are not routinely shared with staff; feedback is limited; staff can list only one quality indicators of program; no formal process in place.				
Score 2					
Score 3	Findings of quality activities are routinely shared with staff; staff can list some quality indicators of program; staff knows some findings of quality reviews; updates about quality initiatives are given to committee members and key staff.				
Score 4					
Score 5	Process in place to update staff about results of quality activities; staff is well aware of quality program goals; entire staff meets to discuss updates about quality improvement activities; staff is actively involved; results of quality activities are communicated with patients and key stake holders.				

E.3. Are patients involved in quality-related activities?					
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**
Score 0	No patients are involved in quality-related activities.				
Score 1	Patient concerns are only discussed as they arise; patient satisfaction is not measured routinely; no structure in place to gather patients' feedback.				
Score 2					
Score 3	Patient needs and/or satisfaction are assessed; feedback of patients is discussed in quality committees; a patient-centered quality activity is launched.				
Score 4					
Score 5	Findings of patient satisfaction assessments are routinely integrated into the quality program; patient-centered advisory board in place; patient-centered feedback is incorporated in setting quality goals; results of quality activities are routinely communicated with patients.				

F) Evaluation of Quality Program

F.1. Is a process in place to evaluate the quality program?					
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**
Score 0	No process in place.				
Score 1	No formal process is established to evaluate the quality program; quality activities are only reviewed if necessary; no review of quality workplan; no annual review of quality goals and infrastructure.				
Score 2					
Score 3	Review of ongoing quality activities by quality committee; quality committee routinely evaluates improvements achieved by quality improvement team(s); some evaluations are used to internally and externally (success stories, etc.) promote the quality program.				
Score 4					
Score 5	Process to assess effectiveness of quality program including workplan, goals, and				

	infrastructure; staff is actively involved; assessments are documented; leadership is well aware and involved in evaluation of quality program; quality awards for staff are given based on evaluations.

F.2. Does the quality program integrate findings into future planning?					
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**
Score 0	No integration of findings into future planning.				
Score 1	Program does not learn from past successes and failures; when annual work plan is established, past performance is not really considered.				
Score 2					
Score 3	Results from evaluations are somewhat used to plan ahead; summary of findings are documented.				
Score 4					
Score 5	Structure in place to use evaluations to facilitate future planning for quality, including identification of improvement opportunities; past performance of performance measurements is used to update work plan, annual goals, and timelines; staff is involved in process; evaluations are used to annually review the quality infrastructure; improvements are spread into wider system, if indicated.				

F.3. Does the program have an information/data system in place to track patient care and measure quality indicators?					
Score 0	**Score 1**	**Score 2**	**Score 3**	**Score 4**	**Score 5**
Score 0	No information system in place.				
Score 1	Has no information system to track patient care; no or very basic medical/patient record system.				
Score 2	Has basic information system to track client care but no specific program information; limited capacity to expand to meet program needs.				
Score 3	Has functional information system to track client care, and some (not all) minimal components of program information system, but no specific quality information.				
Score 4	Has fully functional information system to track client care as well as track all minimal components of program information; limited capacity to easily manage quality with system.				
Score 5	Has fully functional information system to track client care, track core components of program, and produce useful quality of care information.				

Appendix 3: Qualitative exploration of the knowledge, attitude and practices (KAP) of clinical quality and performance assessment amongst South African trained ALS EMS personnel	
Category	**Supporting Quote**
General understanding of quality assessment	*"I think it's very important, and I will give you a little example of why I think it's important. So, when you think of somebody who is rich and somebody who is poor, if you go to somebody's house and the house is dirty, and let's say they're sort of lower income, keeping a house clean does not take a lot of money, or minimal. It's about a level of quality of cleanliness, if you understand what I'm saying? So just because somebody's poor, doesn't mean they shouldn't be clean. So, it's the same sort of thinking," … organisations that are resource limited can still achieve a reasonable sense of quality without all the fancy resources and fancy equipment. It comes down to basic needs of the patient. Yes, I think quality can be maintained, no matter how resource poor any institution or organisation is."* *"So basically, I feel, even in a resource limited setting, I do see the need and requirement for an audit tool of some form, because then we can further see what we are doing, is it right, wrong, or are we incurring harm or are we worsening cases?"*
The role of context in quality assessment	*"I would say that to improve uptake and acceptance, one would need to make it contextually appropriate and relevant and almost be localised adaption at provincial level or lower, but it still aligns itself to a greater set of criteria that is whatever methodology behind it or robustness behind it."* *"No, because if you're going to say that the Western Cape is resource limited, Cape Town central is not the same resource limited that is out in Northern Cape, in Kathu. So out in Kathu they've got one ambulance, so firstly from a human resource point of view they are resource limited. In Cape Town central, in my division, so in one division in Cape Town central, which is the western division, they have got four ALS on every shift."* *""There is financial motivation. If they don't make sure that their quality is up to standard, then they lose the contracts that they have with medical aids, and then their finances get affected."* *"From discussions I've had with private sector paramedics, they are more stringent in private sector, because private sector is, my view is that they are finance driven and if they do not put in information or they don't treat a patient in a certain way, they get penalised. So, the private sector, I think are more tight, in my opinion, on quality processes."*
Factors affecting implementation of quality assessment systems	*"if you get everyone to understand what benefit is there to their patients and what benefit is there to them for doing it, then it can be successful… it doesn't need to be a financial benefit. If I knew as a practitioner that if I took part in a clinical governance process, then I would confidently know that I'm giving the best possible care to my patients, you'd have my buy-in straight away."* *"There definitely needs to be an interactive system, a one sided 'review cases and then slap him down when there a poor interaction' is not particularly valuable. We've always focused on the disciplinary use of it and the corrective portion rather than the encouraging the good."*

	"Perhaps because of the way that it's been managed in the past, where people have had negative experiences, when it becomes a case of let's just tell you no, no, no, this is not how you do it."
Factors affecting on-going utilization of quality assessment systems	*"So, we do have bad apples, but as a whole, if you ask one of the top managers, what is your culture around dealing with mistake/medical error as such, they should be telling you that it is just culture. Now, if someone says that already, then at least you are somewhere. And I like the saying, culture trumps policy every time. We can have whatever policy we have."* *"… to properly implement it, you're going to need appropriate management, and you're going to need management that actually wants to. And in my opinion, I think we have a lot of management that is there simply because they can be there, and not because they take it at heart."*
Quality assessment system reliability and validity	*"…because the staff on the ground are intimately part of improvements. In fact, they are the key role players, so they should know exactly what the targets are, they should know exactly how it's being measured, so they are clear on what the expectations are."* *"If people can understand what you're doing and why you're doing it, you are going to have their buy-in a lot more than just by saying this is what we're doing and you're going to have to accept it. I think they would want to know, and also if you know why it's being done, you probably wouldn't be so sceptical about it or so nervous about it. You would probably embrace it a lot more and understand it."*
Advantages of an effective, efficient quality assessment system	*"So, I think if there was a standard thing implemented it would be huge for patient care, because I think they would pick up problems that they could actually fix for sure, and then I think it would help the staff to just stay more on top of things as a whole as well. I think, also knowing that their care is being watched closer would also prompt people to stay more current and attend more training, do you know what I mean? Like stay on top of things themselves also, because I think that people do get quite complacent there because they are kind of just left to just do what they like."* *"You know, we've only now recently started moving over to looking at quality indicators of positive things, things that we are doing well, instead of only looking at adverse events as quality - or saying we now only have - we've done 100 cases and we only had two reported adverse events. Where now, we are starting to look it actually good things as well."*
Disadvantages of an inappropriate, ineffective quality assessment system	*"And then I think of course that many people in our organisation fear the governance, because they are scared that someone is going to shout at them, they are going to look like an idiot in front of their peer, and I think in that way they probably don't understand what we are trying to achieve and what we're doing. And then some people are also actively against clinical governance, because I am an independent practitioner, so why are you governing me? I got my degree, or I have my diploma or my certificate, you should not govern me, there's no reason for that."* *"…that's where I think it can be a dangerous thing, because you might get people who come and just do what they have to do, just because they want the points, instead of doing it for the best interest in your service and your patients. I think because you don't want people to do something because they are going to get something out it."*

Appendix 4: Quality Indicators reaching consensus agreement - Clinical Category				
Subcategory type	**Applicable Scope of Practice**			**QI Classification**
	Basic Life Support	**Intermediate Life Support**	**Advanced Life Support**	
Acute Coronary Syndromes /ST Elevation Myocardial Infarctions subcategory				
Patients with a provisional diagnosis of ACS/STEMI who had an ALS practitioner in attendance			X	Process
Patients with a provisional diagnosis of ACS/STEMI who had a set of defined cardiac risk factors assessed and recorded		X	X	Process
Patients with a provisional diagnosis of ACS/STEMI who had a 12 lead ECG obtained		X	X	Process
Patients with a provisional diagnosis of ACS/STEMI who were administered Aspirin	X	X	X	Process
Patients with a provisional diagnosis of ACS/STEMI who were administered GTN		X	X	Process
Patients with a provisional diagnosis of ACS/STEMI who were assessed for suitability for thrombolysis by defined checklist		X	X	Process
Patients with a provisional diagnosis of ACS/STEMI who were administered prehospital thrombolysis			X	Process
Patients with a provisional diagnosis of ACS/STEMI who were transported directly to a Facility with PCI capabilities	X	X	X	Process
Patients with a provisional diagnosis of ACS/STEMI who had EMS activation of the receiving Cath Lab	X	X	X	Process
Patients who received/met all components of a defined ACS/STEMI composite bundle score			X	Process
Acute Pulmonary Oedema subcategory				
Patients with a provisional diagnosis of APO who were administered GTN		X	X	Process
Patients with a provisional diagnosis of APO who received CPAP			X	Process
Patients with a provisional diagnosis of APO who had a 12 lead ECG obtained		X	X	Process
Airway Management subcategory				
Patients who received a pre-ETI paralytic, following which there was a decrease in SpO_2 > 10% from baseline/or decrease below 70% overall			X	Process
Patients successfully intubated by EMS personnel where $EtCO_2$ monitoring was used post ETI			X	Process
Patients successfully intubated via RSI by EMS personnel where a paralytic agent was administered post-ETI			X	Process
Patients successfully intubated by EMS personnel where a sedative agent was administered post-ETI			X	Process
Patients successfully intubated by EMS personnel where a mechanical ventilator was used post-ETI for ventilation			X	Process
Patients in whom ETI was attempted by EMS personnel who had an alternative airway inserted as a final airway			X	Process
Patients in whom ETI was attempted by EMS personnel who had a surgical airway inserted			X	Process
Patients successfully intubated by EMS personnel with an $EtCO_2$ < 30 mmHg or > 50 mmHg post-ETI > 10 mins during EMS care			X	Process
Patients in whom RSI with ETI was unsuccessful when attempted by EMS personnel			X	Process

Patients in whom Non-RSI ETI was unsuccessful when attempted by EMS personnel			X	Process
Patients in whom RSI with ETI was successful when attempted by EMS personnel			X	Process
Total number of patients successfully intubated via RSI by EMS personnel			X	Process
Patients who received/met all components of the defined Airway management composite Bundle score			X	Process
Anaphylaxis subcategory				
Patients with a provisional diagnosis of Anaphylaxis and evidence of bronchoconstriction documented who were administered a B2 agonist		X	X	Process
Patients with a provisional diagnosis of Anaphylaxis and evidence of bronchoconstriction documented who were administered an Anti-cholinergic bronchodilator		X	X	Process
Patients with a provisional diagnosis of Anaphylaxis who were administered an antihistamine			X	Process
Patients with a provisional diagnosis of Anaphylaxis who were administered a corticosteroid			X	Process
Patients with a provisional diagnosis of Anaphylaxis and signs of a severe systemic response recorded who were administered IM Adrenaline			X	Process
Asthma/Bronchoconstriction				
Patients with a provisional diagnosis of Asthma/Bronchoconstriction with lung sounds assessed and documented (pre and post treatment)	X	X	X	Process
Patients with a provisional diagnosis of Asthma/Bronchoconstriction with a SpO2 documented (pre and post treatment)	X	X	X	Process
Patients with a provisional diagnosis of Asthma/Bronchoconstriction who were administered a B2 agonist bronchodilator		X	X	Process
Patients with a provisional diagnosis of Asthma/Bronchoconstriction who were administered an anticholinergic bronchodilator		X	X	Process
Patients with a provisional diagnosis of Asthma/Bronchoconstriction who were administered a corticosteroid			X	Process
Patients with a provisional diagnosis of Asthma/Bronchoconstriction recorded with documented severe wheezes/silent chest/BP < 90 mmHg systolic BP who were administered IM Adrenalin			X	Process
Patients who received/met all components of the defined Asthma/Bronchoconstriction composite bundle score			X	Process
Burns subcategory				
Patients with a provisional diagnosis of Burns with burns dressings applied	X	X	X	Process
Patients with a provisional diagnosis of Burns with body surface area and burns type assessed and recorded	X	X	X	Process
General subcategory				
Serviceable suction unit devices available per defined area and/or time period		N/A		Structure
Serviceable 3 lead ECG monitoring devices available per defined area and/or time period		N/A		Structure
Serviceable 12 lead ECG monitoring devices available per defined area and/or time period		N/A		Structure
Serviceable portable oxygen cylinders available per defined area and/or time period		N/A		Structure
Serviceable Defibrillator/AED devices available per defined area and/or time period		N/A		Structure

Serviceable mechanical ventilators available per defined area and/or time period	N/A			Structure
Patients with reduced level of consciousness with a blood glucose measured	X	X	X	Process
Patients with a recorded SpO2 < 95% who were administered supplemental Oxygen	X	X	X	Process
Patients with a provisional diagnosis recorded	X	X	X	Process
Hypoglycaemia subcategory				
Patients with a blood glucose level < 5 mmol who were administered Glucose	X	X	X	Process
Patients with a blood glucose level measured and recorded following Glucose administration	X	X	X	Process
Neonate/Paediatric subcategory				
One min APGAR score assessed and recorded for newborn patients	X	X	X	Process
Five min APGAR score assessed and recorded for newborn patients	X	X	X	Process
Paediatric patients with a provisional diagnosis of Croup who were administered oral/inhaled steroids			X	Process
Paediatric patients with a provisional diagnosis of Croup who were administered nebulized Adrenalin			X	Process
Patient transportation to a facility with specialist Paediatric capabilities/resources	X	X	X	Process
Obstetrics subcategory				
Obstetric patients who deliver prior to EMS arrival	X	X	X	Process
Obstetric patients with postpartum haemorrhage who were administered TXA			X	Process
Obstetric patients with a provisional diagnosis of Eclampsia or Pre-eclampsia who were administered Magnesium sulphate			X	Process
Obstetric patients who deliver during EMS care	X	X	X	Outcome
OHCA subcategory				
Patients with a provisional diagnosis of OHCA with a witnessed collapse documented	X	X	X	Process
Patients with a provisional diagnosis of OHCA who received documented bystander CPR	N/A			Process
Patients with a provisional diagnosis of OHCA who received documented telephonic CPR advice	N/A			Process
Patients with a provisional diagnosis of OHCA with VF/VT as first presenting rhythm on arrival of EMS	X	X	X	Process
Patients with a provisional diagnosis of OHCA with Asystole/PEA as first presenting rhythm on arrival of EMS	X	X	X	Process
Patients with a provisional diagnosis of OHCA intubated with alternative airway device			X	Process
Patients with a provisional diagnosis of OHCA for whom resuscitation was cancelled prior to arrival at hospital			X	Process
Patients with a provisional diagnosis of OHCA who were transported to hospital (incl. ROSC and Non-ROSC patients)	X	X	X	Process
Patients with a provisional diagnosis of OHCA with ROSC at hospital handover	X	X	X	Process
Patients with a provisional diagnosis of OHCA with VF/VT at hospital handover	X	X	X	Process
Patients with a provisional diagnosis of OHCA with Asystole/PEA at hospital handover	X	X	X	Process

Patients with a provisional diagnosis of OHCA with survival to Emergency Centre discharge	X	X	X	Process
Patients with a provisional diagnosis of OHCA with survival to hospital discharge	X	X	X	Outcome
Pain Management subcategory				
Patients with level of Pain measured via defined pain score	X	X	X	Process
Patients with a defined pain score threshold who were administered analgesia		X	X	Process
Patients with level of pain measured via defined pain score following analgesia administration	X	X	X	Process
Seizures subcategory				
Patients with a provisional diagnosis of Seizures with a blood glucose measured and recorded	X	X	X	Process
Patients with a provisional diagnosis of Seizures who were administered an antiepileptic for ongoing Seizures			X	Process
Stroke/TIA subcategory				
Patients with a provisional diagnosis of Stroke/CVA/TIA with a blood glucose measured and recorded	X	X	X	Process
Patients with a provisional diagnosis of Stroke/CVA/TIA with a Stroke screening assessment performed (e.g.: FAST)	X	X	X	Process
Patients with a provisional diagnosis of Stroke/CVA/TIA with serial blood pressure measurements recorded (X3)	X	X	X	Process
Patients with a provisional diagnosis of Stroke/CVA/TIA delivered to a specialist Stroke Centre	X	X	X	Process
Patients with a provisional diagnosis of Stroke/CVA/TIA with direct delivery to CT scan	X	X	X	Process
Patients who received/met all components of the defined Stroke/CVA/TIA composite bundle score	X	X	X	Process
Trauma subcategory				
Patients designated as a trauma case with entrapment on scene documented	X	X	X	Process
Patients designated as a trauma case with a BP < 90 mmHg		N/A		Process
Patients designated as a trauma case with partial/full amputation who had a tourniquet applied	X	X	X	Process
Patients designated as a trauma case with a femur fracture and traction splint use	X	X	X	Process
Patients designated as a trauma case with a BP < 90 mmHg who were administered TXA			X	Process
Patients designated as a trauma case with direct transportation to a specialist Trauma Centre	X	X	X	Process

Quality Indicators reaching consensus agreement – Non-clinical Category				
Subcategory type	**Applicable Scope of Practice**			**QI Classification**
	Basic Life Support	**Intermediate Life Support**	**Advanced Life Support**	
Adverse Events subcategory				
Number of patient deaths while in EMS care	X	X	X	Adverse Event
Number of defined Adverse Events reported during EMS care	X	X	X	Adverse Event
Number of defined equipment/technical failures reported during EMS care	N/A			Adverse Event
Number of accidental or unexpected extubations reported during EMS care			X	Adverse Event
Number of patients with a decrease in GCS of 3 or more points during EMS care	X	X	X	Adverse Event
Number of defined failed intubation attempts	X	X	X	Adverse Event
Total number of patient injury reports during EMS care	X	X	X	Adverse Event
Number of EMS staff on-duty injury reports	N/A			Adverse Event
Number of defined medication errors during EMS care	X	X	X	Adverse Event
Communications/Dispatch subcategory				
Number of cases compliant with defined ALS Dispatch criteria	N/A			Structure
Number of cases with call processing time within defined limits	N/A			Structure
Number of Service Call Centre calls received per 10000 population	N/A			Structure
Number of unanswered/missed calls to the Service Call Centre	N/A			Structure
Number of cases with a delay in dispatch and/or response time waiting for a police/security escort	N/A			Process

ACS – Acute Coronary Syndrome; **AED** – Automated External Defibrillator; **ALS** – Advanced Life Support; **APGAR** – Activity, Pulse, Grimace, Appearance, Respiration; **APO** – Acute Pulmonary Oedema; **BBA** – Born before arrival; **BP** – Blood pressure; **CPD** – Continued professional development; **CPR** – Cardiopulmonary resuscitation; **CT** – Computed tomography; **CVA** – Cerebrovascular accident; **ECG** – Electrocardiogram; **EMS** – Emergency Medical Service; **EtCO2** – End tidal carbon dioxide; **ETI** – Endotracheal intubation; **ETT**- Endotracheal tube; **FAST** – Face Arm Speech Time; **GCS** – Glasgow Coma Scale; **GTN** – Glyceryl trinitrate; **HEMS** – Helicopter Emergency Medical Service; **IO** – Intra-osseous; **IOD** – Injury on duty; **IV** – Intravenous; **MAP** – Mean arterial pressure; **mmHg** – Millimeters mercury; **ODD** – Oesophageal detection device; **OHCA** – Out of hospital cardiac arrest; **PCI** – Percutaneous coronary intervention; **PEA** – Pulseless electrical activity; **PEFR** – Peak expiratory flow rate; **POC** – Point of care; **ROSC** – Return of spontaneous circulation; **RSI** – Rapid sequence intubation; **SPC** – Statistical process control; **SpO2** – Capillary oxygen saturation; **STEMI** – ST elevation myocardial infarction; **TIA** – Transient Ischaemic attack; **TXA** – Tranexamic acid; **VF** -Ventricular fibrillation; **VT** – Ventricular tachycardia

Appendix 5: Literature review of evidence base																
Indicator Category	**Indicator subcategory**	**Total QIs**	**Indicator Type**				**Level of Evidence**									
			Structure	**Process**	**Outcome**	**Adverse Event**	**1a**	**1b**	**1c**	**2a**	**2b**	**2c**	**3a**	**3b**	**4**	**5**
Clinical	Acute Coronary Syndromes	25		23	2					4	5				2	14
	Airway management	8		8							2		1		1	2
	Acute Pulmonary Oedema	2		2						2						
	Asthma	10		10						1						9
	General	18		15	3					2					4	12
	Hypoglycaemia	3		3												3
	Out of hospital cardiac arrest	44	4	38	2					2					3	39
	Pain management	1		1												1
	Seizures	2		2						2						
	Stroke	11		11							3					8
	Trauma	16	3	11	2					4			5			6
Non-clinical	Adverse Event	25				25					9			11		5
	Deployable resources	15	13	2	2										5	13
	Dispatch/Call times	90	7	73	6					3	1		26	17	4	39
	Documentation	16	3	13								2		2	3	11
	Employee focused	16	16											2	2	12
	Service user rating/satisfaction	9		6	3										1	8
Total		311	46	218	20	25	0	0	0	20	20	2	32	32	25	182
%			15%	70%	6%	8%	0%	0%	0%	6%	6%	1%	10%	10%	8%	59%

QI – Quality indicator

Appendix 6: Qualitative exploration of the Quality Program Assessment		
Participating Service & Interviewee	**Sub-category**	**Supporting Quote**
1 Western Cape Director level participant	Leadership	"We're at the disadvantage where [the director] who normally drives this [quality] has been away for probably almost two years now and as a consequence, much of these questions where we had answered reasonably well before, realistically speaking we are nowhere near that because the person responsible for coordinating that has not been here"
	Mandate	"I'm of the view that in the South African context, we are a logistics company, we are not a medical company…we are a transport system"
	Historical factors	"Because of the nature of the South African services, because of the socio-political aspects of the way cities are structured in South Africa, particularly in Cape Town, response time performance had to be prioritised, due to spatial divide… our cities are racially designed which means in a post-democratic country, in a way to break that up, you have to put a transport system in place, so that the racial divide, the inequity isn't perpetuated, and where you don't have a public transport system, when it comes to healthcare, that's the primary purpose of ambulance service"
	Safety	"so, what has happened as a consequence of safety, as a consequence of all of these ambulance attacks, one of the things we've had to do, we've had to engage with the community more often, so what is happening relatively frequently, is we attend patient health forums. The district managers must attend or send a representative to every community health forum meeting or community safety forum meeting. So, at these sessions, a patient voice invariably comes through"
2 KwaZulu Natal Deputy Director level participant	Structure	"EMS in KwaZulu Natal has a provincial M&E (measurement and evaluation) manager and then one FIO (facility information officer) per district. We have eleven districts in total. Information and quality currently measured are focused on service delivery. The quality of medical care provided to patients is an area that is currently lacking. A set of indicators is reported on monthly by each district using an excel spreadsheet, this is a huge challenge as data is manually captured at each level from the source to final consolidation and reporting"
		"We do have a quality plan in place. This is reviewed annually. The plan takes into account available resources, available budget and timeframes. The plan contains mainly issues around service delivery and strategies to improve service delivery. The plan is reviewed by the EMS management team which includes the EMS provincial management team and EMS district managers."
	Mandate	"When we measure quality of services, we look at the national norms currently available together with the demand for services. Firstly, we look at available resources and how we compare to the 1 ambulance per 10 000 population national norm. Then we look at the demand for services - what the available resources had to attend to. And then we look at the percentage P1 cases responded to within the national norms. These are all viewed as a piece of the complete puzzle and should not be measured or reported on independently as the picture will be incomplete. The assumption is that, if you have 1 ambulance per 10 000 population then you should be able to achieve the response time norms to P1 cases taking into account your case load has not spiked due to any unforeseen circumstance"

		"This is the focus of our performance measured on a continuous basis where trends are monitored on a monthly, quarterly and annual basis. Other quality indicators are measured as and when required, particularly if we have a special project or intervention in place."
	Engagement	"performance results are presented at our EMS management team forum and distributed to districts by the provincial M&E manager. EMS district managers are encouraged to present their performance to staff at all levels within the districts, but this is not happening in all districts"
		"As EMS we do not have much public engagement regarding our performance however our performance reports are included in the departmental annual reports which are public documents. These are also discussed at public imbizo events where the public has an opportunity to pose questions, concerns, comments to the departments senior management where EMS is represented"
3 Limpopo Director level participant	Strategic planning	"The EMS plan fits into the broader department strategic plans, where we have a section that is focused on EMS… the strategic plans are updated and planned for over several years and then re-evaluated at the end of that period. Where we have failed to reach a target or goal, we re-incorporate those projects into future plans"
	Relationships	"We form part of the (health) departments system as a whole and filter into the departments committees… for me the most important thing is the relationship we have with them. I would rather we have someone with an understanding of quality and quality systems and improve their understanding of EMS, than have someone from EMS and need to bring their understanding up to understand quality. But either way, for me the most important thing is still about the relationship we have with them"
		"We measure quality through response times targets, through the number of complaints, and from feedback from the facilities we take patients to. Their feedback about the interaction with our staff is very important to me."
	Attitude	"The attitude of the staff is very important to me, and that's one of the biggest improvements we have planned for... It will be very difficult, but we want to involve organized labour, and invite them to be a part of the process… here they determine success or failure and that's why I want to make sure they have buy-in to the process and provide feedback"
	Technology	"Having systems in place such as CAD systems will allow us to monitor everything involving staff, vehicles, how they are used, all of which will allow us to monitor our performance more closely and to make the sure the staff are held responsible and accountable, because this will also allow us to provide extra information to the public as a measure of our performance as well"
4 North West Director level participant	Structure	"We're not a provincialized service, we're a totally decentralised service, each EMS station reports to the subdistrict they are in, so there's no provincial structure. Currently we are the only province that is like that… Basically we've got like 19 different EMS services in the North West."
	Staff capacity	"we lost a lot of them to OSD (occupational specific dispensation) …the OSD has shot us in the foot. We're losing a lot of staff because we can't retain them, so we're training, but we're actually training for [other services]"
	Non-personal resources	"I'm finding out from research that we don't need such a high amount of ambulances, we need to be focusing more on planned patient transport, because 65% of our calls are actually P3, so we're using a very expensive resource to transport something that we don't need to transport"
	Technology	"the unfortunate thing is all our stuff is paper-based, and we don't have a digital system. So, we are moving towards a digital communication system, but currently it's very easy to lie to your statistics, so I cannot trust the information given to me"

5 Private Service Senior manager level participant	Leadership	"We're probably as good as a 5 as you can get, in my opinion. [Representatives] From the CEO, to the operational crews sit on a clinical committee, there's a quality assurance manager that sits at an executive level, and all of this works through, it's all auditable through minutes and committee meetings that report into the executive committee"
	Representation	"we've got representatives from cross the organisation sitting on the clinical panel to discuss what the consumer wants, what training needs to be provided, what operations is currently doing and where the operations within operations is needed"
	Improvement focus	"If we're doing a quality improvement project, if it gets written down as a quality improvement project, and not just an intervention, then we do put the assurances in place, putting in the checks to monitor it over and time and then look at whether there's a consistent change in behaviour or not"
	Fit for purpose	"our biggest problems in terms of this are systems. We often review stuff, and we often see, and we might know what quality indicators to use, but the problem comes in that the system we currently have is, manual, and very hard to change any kind of quality indicators, because it's an accounting system that we're using for quality indicators essentially, and it's still paper-based, and manually captured"
	Patient/community engagement	"In terms of a structured patient satisfaction assessment, we do have that. In terms of having a point of entry into the business for patients concerns to be brought up, we do have that, that's very well developed at [parent company]. I think the problem comes in when you start talking about patient or community engagement when it comes to patient centred events, and I don't think we're there yet."

Emergency Medicine Australasia

Emergency Medicine Australasia (2019) doi: 10.1111/1742-6723.13302

ORIGINAL RESEARCH

Knowledge, attitude and practices of clinical quality and performance assessment among emergency medical services personnel in South Africa: A mixed methods study

Ian HOWARD [1,2] Peter CAMERON,[3] Maaret CASTRÉN,[4] Lee WALLIS[2] and Veronica LINDSTRÖM[5]

[1]Department of Clinical Science and Education, Södersjukhuset, Karolinska Institutet, Stockholm, Sweden, [2]Division of Emergency Medicine, Stellenbosch University, Stellenbosch, South Africa, [3]School of Public Health and Preventive Medicine, Monash University, Melbourne, Victoria, Australia, [4]Department of Emergency Medicine and Services, Helsinki University Hospital, Helsinki University, Helsinki, Finland, and [5]Karolinska Institutet, Department of Neurobiology, Care Sciences, and Society Division of Nursing Sweden, Academic EMS, Stockholm, Sweden

Abstract

Objective: Deficits in healthcare quality are becoming an increasing concern globally. Within the low- to middle-income country (LMIC) setting insufficient quality has become a bigger barrier to reducing mortality than insufficient access, where 60% of deaths from conditions amenable to healthcare, are due to poor quality care. Measuring quality is key towards improving the effectiveness of healthcare in this setting.

Methods: A mixed methods sequential-explanatory study was conducted, to describe what Emergency Medical Service (EMS) practitioners understood about quality systems within the LMICs, using South Africa as an example. Part 1 consisted of a cross-sectional survey (n = 169), the results of which were utilised to develop a semi-structured interview guide for Part 2. Interviews of participants from Part 1 explored the results of the survey (n = 20) and were analysed through content analysis to develop core categories central to the understanding of quality assessment in the LMICs.

Results: Despite relatively poor knowledge of organisational-specific quality systems, understanding of the core components and importance of quality systems was demonstrated. The role of these systems in the LMICs was supported by participants, where the importance of context, system transparency, reliability and validity were essential towards achieving ongoing success and utilisation. The role of leadership and communication towards the effective facilitation of such a system was equally identified.

Conclusion: Within EMS, quality systems are in their infancy. It could be argued that this is somewhat more pronounced in the LMICs, where knowledge of organisational quality systems was found to be poor. Despite this, there was a strong general understanding of the importance of quality systems, and the role they have to play in this setting.

Key words: *emergency medical services, healthcare quality, KAP survey, mixed methods, patient safety, sequential explanatory.*

Key findings

- There is relatively poor knowledge of organisational specific quality systems among advanced life support practitioners in South Africa.
- The need for strengthening quality systems in the low- to middle-income country setting is well supported by practitioners.
- System transparency, facilitated by open communication, supported by engaged leadership are essential components towards achieving a successful quality system in the EMS setting.

Introduction

Deficits in the quality of healthcare are becoming an increasing concern globally, across all setting.[1–4] However, nowhere is this more applicable than in the low- to middle-income country (LMIC) setting.[1–4] Insufficient quality of care in the LMICs has become a bigger barrier to reducing mortality than insufficient access, where 60% of deaths from conditions amenable to healthcare are due to poor quality care.[1–4] Measuring quality is key to accountability and improvement, and the role of quality systems will be central to improving the delivery and effectiveness of healthcare in the LMICs.[1–4]

Based on the Wold Bank's analytical classification of world economies, South Africa (SA) is grouped among the LMICs.[5] Similarly, healthcare in SA shares several attributes common

Correspondence: Mr Ian Howard, Department of Clinical Science and Education, Södersjukhuset, Karolinska Institutet, Solnavägen 1, 171 77 Solna, Sweden. Email: ianhoward@outlook.com

Ian Howard, BEMC, MPhil, PhD Student; Peter Cameron, MD, FACEM, Professor; Maaret Castrén, MD, Professor; Lee Wallis, MBChB, FRCEM, Professor; Veronica Lindström, RN, Associate Professor.

Accepted 29 March 2019

to health systems across the LMICs.[3,6] Recent Department of Health policy reviews have highlighted the importance of developing systems for implementing and monitoring the quality of healthcare in the country.[7] Within the Emergency Medical Service (EMS) environment, efforts by the governing body of EMS in SA have signified a desire to professionalise the service through amendments to the training and qualification frameworks, and adopting a greater evidence-based approach towards the national scope of practice.[8] However, little has been done towards ensuring the realisation of appropriate and effective quality systems in the country.

Before widespread changes towards strengthening quality systems can be made, it is important to determine the current understanding of these systems by EMS practitioners, given the potential impact of such changes within the profession. As a result, we sought to identify current knowledge, attitudes and practices of clinical quality and performance assessment among emergency medical services personnel in the LMICs, from the South African perspective.

Methods

The present study used a mixed methods sequential explanatory design,[9] divided into two parts: Part 1 consisted of a web-based cross-sectional survey, and Part 2 consisted of semi-structured telephonic interviews of select participants from Part 1 to explore the results of the survey (Fig. 1).

Setting and participants

Structurally, EMS in SA is based on a three-tiered system of basic, intermediate and advanced life support (ALS) levels of qualification, as can be found in systems across North America, the United Kingdom and Australia. Similarly, each level is licenced for independent practice and governed by a centralised body.[10] These services are provided across the country, with varying coverage, through a combination of government-funded and privately funded services. The target participants were South African trained EMS practitioners registered at the ALS level. The restriction to ALS providers was based on the extensive scope of practice employed at this level, compared with the intermediate and basic providers, and given that ALS practitioners largely constitute the core of mid and senior level managers within South African EMS.

Practitioners from both private and government EMS, practitioners working in non-conventional EMS roles (i.e. remote site/primary care setting; education), as well as those practitioners working abroad who maintain a South African registration, were considered for inclusion in attempt to achieve variation among participants to recognise potential differences in understanding based on service type and setting.

Data collection

Part 1: Baseline cross-sectional survey

No previously literature was identified examining the research problem in question. The survey tool used was developed for the purposes of this study, utilising a knowledge-attitude-practices (KAP) survey framework to guide development.[11,12] Prior to dissemination the survey was reviewed by five ALS practitioners with formal research training, to assess face and content validity and provide feedback on content, structure and format. The survey was pilot tested on an additional five preselected ALS practitioners to further aid refinement regarding clarity, brevity and survey flow.

A final 60 item survey was developed focused on employment; the participant's understanding of clinical quality and performance assessment in general; within their organisation; and for use to facilitate improvement and education. The survey was composed of closed-ended, multiple choice and visual analogue scale questions. All surveys were distributed in English and completed via a web-based survey tool

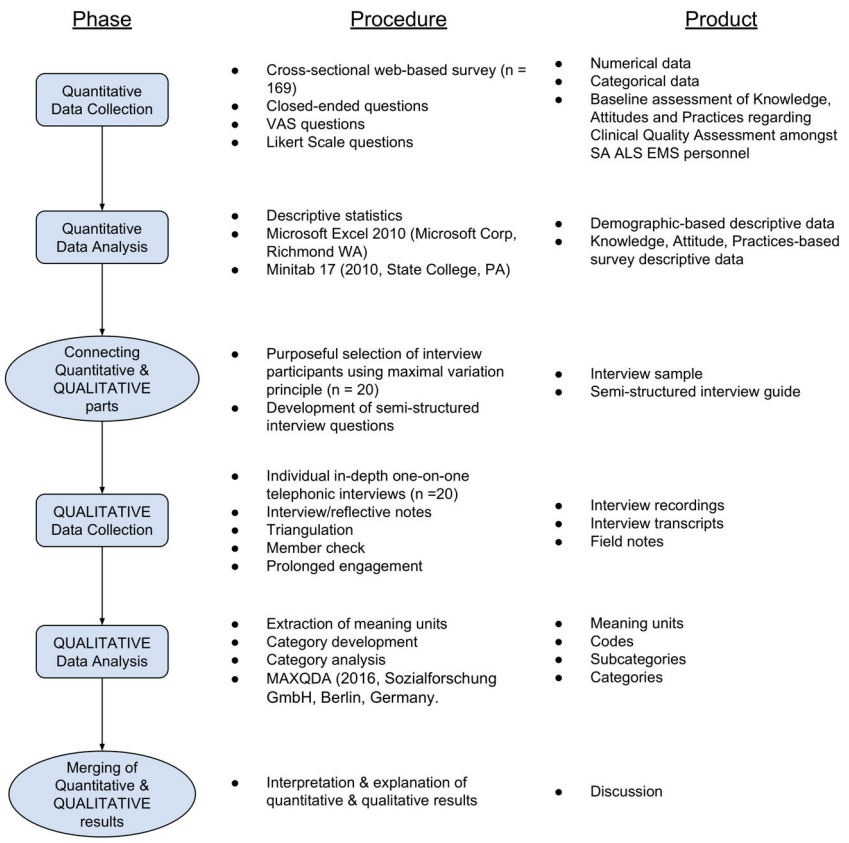


Figure 1. *Visual model.*

(Checkbox; Checkbox Survey Solutions, Watertown, MA, USA).

Using a sample size estimation for a single proportion calculation, a minimum sample of 136 was required for the survey, based on a population of approximately 1200, with a confidence/significance level of 95% and margin of error of 8%. Several methods were employed to disseminate the survey, including email, ALS job boards and social media. Several reminders were sent, and data collection continued until the sample size was achieved, and there was sufficient perceived variation in the setting and industry of respondents. The survey response was coded and therefore anonymous, with the exception of participants who volunteered for inclusion into Part 2. All known participant identities were kept confidential and known to the researchers only.

Part 2: Semi-structured interviews

The summarised results from the survey were used to develop a semi-structured interview guide for Part 2. For the interviews, a maximal variation sampling strategy was used to ensure the inclusion of multiple participant perspectives.[13] A combination of self-selected participants from the survey, in conjunction with recruited participants meeting demographic criteria unaccounted for in the self-selected group, were included. The interview guide consisted of open-ended questions to explore the survey results and focused on the participants general understanding of quality and performance assessment; their exposure to quality assessment in their own organisations and the potential impact of such systems on the broader resource limited setting. All interviews were conducted in English and recorded for transcription and analysis. Reflective notes were maintained during each interview, and immediately after, for verification of the interview results during analysis.

Priority, integration and merging

Priority in this sequential explanatory design was given to Part 2, the

TABLE 1. *Demographic data*

	n	%
Total responses included in final analysis	169	
Employment location		
South Africa – full time	102	60.4%
South Africa – part time	35	20.7%
Outside South Africa	32	18.9%
Approximate time period spent working in the emergency medical services		
<1 year	1	0.6%
1–5 years	22	13.0%
6–10 years	40	23.7%
11–15 years	54	32.0%
16–20 years	26	15.4%
>20 years	26	15.4%
Approximate time period spent working as advanced life support		
<1 year	11	6.5%
1–5 years	41	24.3%
6–10 years	49	29.0%
11–15 years	46	27.2%
16–20 years	9	5.3%
>20 years	13	7.7%
Classification of organisation (may be multiple)		
Government/public EMS	77	45.6%
Private EMS	68	40.2%
Remote site/off-shore	20	11.8%
Government/public air medical service	29	17.2%
Private air medical service	10	5.9%
Education/training	24	14.2%
Health and safety industry	7	4.1%
Primary healthcare	1	0.6%
Medical equipment/supplies sales	0	0.0%
Other	12	7.1%
None of the above	3	1.8%
Current role (may be multiple)		
Senior management	16	9.5%
Middle management	29	17.2%
Education/training	37	21.9%
Communications	1	0.6%
Clinical operations – Ground	104	61.5%
Clinical operations – Air	40	23.7%
Quality assurance/governance	27	16.0%
Primary healthcare	10	5.9%
Other	4	2.4%
None of the above	5	3.0%

qualitative component. Integration involved connecting the results from Part 1, to develop questions that needed to be further explored in the follow-up interviews in Part 2.[14] Merging of the results from Parts 1 and 2 is presented in the discussion.

Data analysis

Part 1: Baseline cross-sectional survey

Data were entered and analysed using a combination of Microsoft Excel 2010 (Microsoft Corp., Richmond, WA, USA) and Minitab Version 17 (2010; State College, PA, USA). Descriptive statistics were carried out to summarise and present all survey items.

Part 2: Semi-structured interviews

Conventional content analysis[15] was employed to analyse the interview data, using MAXQDA software for data storage; extraction of meaning units and sub-category and category development (MAXQDA, 2016; Sozialforschung GmbH, Berlin, Germany). Prior to analysis, each interview transcript was reread for content familiarisation. First-level coding was conducted through the extraction of meaning units from each transcript and summarised into codes using open-coding from each interview. Once completed, similar codes across all interviews were combined and organised to develop clustered sub-categories. Throughout the first-level coding and sub-category development, the reflective notes were referenced for verification. Lastly, broad over-arching categories were identified that emerged from similar grouped sub-categories.

Multiple methods were used to ensure internal validity (Trustworthiness) and included: triangulation of the recorded interviews, transcripts, reflective notes and the derived codes, sub-categories and categories; prolonged participant engagement throughout both the survey and interviews; and member-checking using a sample of the interviews to confirm the results of the analysis.[16]

Ethical approval for the study was granted by the Stellenbosch

TABLE 2. *Knowledge-based survey data*

	n	%
Total responses included in final analysis	169	
Are you required to complete a patient care report form to document patient care/management?		
Yes	160	94.7%
No	9	5.3%
I do not know	0	0.0%
Not applicable	0	0.0%
Does your patient care documentation undergo review to assess the quality of patient care delivered?		
Yes	124	73.4%
No	19	11.2%
I do not know	25	14.8%
Not applicable	1	0.6%
Does your organisation have a quality assurance/governance department or any similar type of department?		
Yes	136	80.5%
No	21	12.4%
I do not know	12	7.1%
Not applicable	0	0.0%
Who is responsible for the assessment of quality in your organisation?		
Operational ALS	19	11.2%
Shift supervisor	12	7.1%
Base supervisor	6	3.6%
QA dept	82	48.5%
I do not know	21	12.4%
N/A	6	3.6%
Other	25	14.8%
Are the criteria used to assess the quality of your patient care made available to you?		
Yes	71	42.0%
No	86	50.9%
I do not know	0	0.0%
Not applicable	12	7.1%
Are the results of any form of review for quality of patient care made available to you?		
Yes	91	53.8%
No	64	37.9%
I do not know	0	0.0%
Not applicable	14	8.3%
Are the results of these overall performance evaluations linked to certain types of incentives such as extra time off; increased pay; bonuses etc.?		
Yes	88	52.1%
No	52	30.8%

TABLE 2. *Continued*

	n	%
I do not know	16	9.5%
Not applicable	13	7.7%
Are the results of these overall performance evaluations linked to certain types of penalties such as less time off; pay deduction; removal of bonuses etc.?		
Yes	47	27.8%
No	85	50.3%
I do not know	25	14.8%
Not applicable	11	6.5%
Are the results of any assessment for the quality of your patient care discussed with you in your overall performance evaluation?		
Yes	71	42.0%
No	67	39.6%
I do not know	17	10.1%
Not applicable	14	8.3%
Does your organisation provide opportunities for continuing medical education (CME)?		
Yes	102	60.4%
No	33	19.5%
I do not know	0	0.0%
Not applicable	6	3.6%
Not answered	28	16.6%
Does your organisation provide CME activities where the subject/topic is based on the results of a quality review?		
Yes	47	27.8%
No	63	37.3%
I do not know	27	16.0%
Not applicable	4	2.4%
Not answered	28	16.6%

University Health Research Ethics Committee S15/09/193).

Results

Part 1: Baseline cross-sectional survey

Two hundred and twenty responses were returned. Fifty-one incomplete responses were excluded, because of a lack of sufficient information, leaving a total of 169 (74%) responses for final analysis. The majority (81.1%) of participants worked within SA and had 6–15 years' experience as ALS (56.2%) (Table 1).

Knowledge

The majority (73.4%) of participants were aware that their clinical documentation underwent some form of review for quality of care delivered (Table 2). However, less than half (48.5%) of respondents indicated that these activities were performed by a dedicated quality department, or were aware what criteria were used to assess their quality (50.9%).

While the majority (60.4%) of participants indicated that their organisation provided opportunities for continued medical education (CME) activities, there was little indication that the subject matter/topic of these activities was developed as a form of targeted improvement following a quality review (37.3%).

Attitude

There was agreement among participants regarding the desire to know: who was responsible for the review of their quality (91.1%); what criteria were used (92.9%); how quality of care was assessed (92.3%); and that these should both be made available to them (91.7%) (Table 3).

There was variation among participants with regards to incentivising the results of a quality review, with 43.2% in disagreement and 47.9% in agreement. There was similar variation as to whether respondents felt such an incentive scheme would have a positive result on their performance. In contrast, when questioned as to whether they felt the review of a practitioner's quality should be linked to a punitive system, the majority (56.8%) disagreed.

Practices

The results of a quality review were made available to participants via a multitude of methods, with email (23.1%) and dedicated presentation days (21.3%) the most common and equally preferred (65.1% and 57.4%, respectively) (Table 3). Nineteen percent of participants indicated that such information was not made available to them. Approximately half (52.5%) of respondents indicated the desire to have at least monthly reporting regarding quality assessment (Table 4).

Part 2: Semi-structured interviews

Data saturation was achieved after 18 interviews, following which an additional two were conducted for assurance. Interview length varied between 35 and 112 min with an average of 46 min. Overall, seven categories emerged exploring the participants understanding of quality assessment within South African EMS and included the following (Table 5):

General understanding of quality assessment

A general understanding among participants was demonstrated on several levels and extended beyond just a practical focus. From a conceptual point of view, participants understood that quality assessment is a fundamental, albeit complex component of healthcare, not only within SA, but within the broader LMICs.

The role of context in quality assessment

The importance of context continuously emerged as a central component, where there was widespread consensus that quality systems should be specifically designed for or tailored to setting and purpose. In terms of South African EMS, there was significant commentary regarding the variation in current systems between government and private-funded EMS, rural and urban areas and between provinces.

TABLE 3. *Attitude-based survey data*

	Strongly disagree		Disagree		Neutral		Agree		Strongly agree	
It is important to document my patient care/management/interaction	3	1.8%	4	2.4%	7	4.1%	26	15.4%	129	76.3%
It is important that my patient care documentation is reviewed to assess quality	2	1.2%	9	5.3%	7	4.1%	26	15.4%	125	74.0%
It is important that several methods are used to assess quality, in addition to documentation review	2	1.2%	6	3.6%	10	5.9%	46	27.2%	105	62.1%
It is important to know who is responsible for the assessment of quality my organisation	4	2.4%	2	1.2%	9	5.3%	36	21.3%	118	69.8%
The criteria used to assess the quality of my patient care should be made available to me	2	1.2%	5	3.0%	5	3.0%	35	20.7%	122	72.2%
I feel it is important that I understand how quality is assessed	2	1.2%	5	3.0%	6	3.6%	31	18.3%	125	74.0%
The results of a quality review should be made available	2	1.2%	3	1.8%	9	5.3%	27	16.0%	128	75.7%
The results of a quality review should be linked to certain types of incentives if my care was assessed to be good	52	30.8%	21	12.4%	15	8.9%	31	18.3%	50	29.6%
The results of a quality review should be linked to certain types of penalties if my care was assessed to be poor	75	44.4%	21	12.4%	21	12.4%	19	11.2%	33	19.5%
The quality of patient care would improve if the results of a quality review were linked to a reward system	54	32.0%	17	10.1%	22	13.0%	26	15.4%	50	29.6%
The quality of patient care would improve if the results of a quality review were linked to a penalty system	67	39.6%	20	11.8%	14	8.3%	32	18.9%	36	21.3%
I have the support of my organisation if errors are found during a quality review of my patient care	25	14.8%	33	19.5%	19	11.2%	46	27.2%	46	27.2%
The results of a quality review should be part of my overall performance evaluation	4	2.4%	7	4.1%	12	7.1%	40	23.7%	106	62.7%

Private services were perceived to be more advanced regarding the utilisation of quality assessment tools and frameworks. However, there was agreement that this was largely based on a financial motivation and to a less extent, perceived legal ramifications if not adequately performed.

Factors affecting implementation

Communication as a function of implementation was found to be essential towards achieving buy-in among staff, especially considering the desire for participants to understand the assessment process, and the importance this understanding brings in terms of participation.

The historical connotations and stigma of current systems that were poorly designed and implemented emerged as a factor affecting future systems, and further emphasised the important role effective, early communication has to play.

Factors affecting ongoing utilisation

Ongoing and open sharing of information, and the general inclusion of frontline staff was perceived to be a central driver towards promoting a culture aimed at prioritising quality within an organisation. Similarly, the role of management and leadership were seen as essential towards ensuring this. There was general consensus among the participants that the lack of leadership input or involvement largely contributed to the poor culture, motivation and prioritisation regarding quality currently seen in the systems that exist in SA.

System validity and reliability

The demonstration of an objective, transparent quality system that was consistently applied was not only key to ensure success but was noted to be all too absent regarding systems currently employed in EMS in SA.

Advantages of an effective, efficient system

Effective quality assessment was understood to be a facilitator of a

TABLE 4. *Practices-based survey data*

	n	%
Total responses included in final analysis	169	
What other methods are used to assess the quality of patient care in your organisation? (may be multiple)		
Supervised shifts/ride along	49	29.0%
Written exams	20	11.8%
Oral exams	29	17.2%
Simulations	51	30.2%
Skills assessments	67	39.6%
I do not know	10	5.9%
No other way	33	19.5%
Quality not assessed	18	10.7%
Other	9	5.3%
None of the above	3	1.8%
How often does your patient care undergo assessment for quality of care in your organisation?		
Everyday	33	19.5%
Once a week	9	5.3%
Once a month	38	22.5%
Once a year	8	4.7%
Not applicable	9	5.3%
I do not know	50	29.6%
Not assessed	9	5.3%
Other	15	8.9%
How often do you feel your patient care should undergo assessment for quality of care in your organisation?		
Everyday	43	25.4%
Once a week	21	12.4%
Once a month	54	32.0%
Once every 3 months	35	20.7%
Once every 6 months	11	6.5%
Once a year	3	1.8%
I do not know	4	2.4%
Other	0	0.0%
How are these results made available? (may be multiple)		
Verbally	26	15.4%
Email notifications	39	23.1%
Notice board announcement	23	13.6%
Presentations on dedicated days	36	21.3%
Results are not made available	32	18.9%
Not applicable	28	16.6%
Other	12	7.1%

TABLE 4. *Continued*

	n	%
How would you prefer these results to be made available to you? (may be multiple)		
Verbally	46	27.2%
Email notifications	110	65.1%
Notice board announcement	28	16.6%
Presentations on dedicated days	97	57.4%
I do not want the results made available	2	1.2%
Other	4	2.4%
Not applicable	11	6.5%
How often are these results made available?		
Everyday	11	6.5%
Once a week	14	8.3%
Once a month	38	22.5%
Once every 6 months	11	6.5%
Once a year	5	3.0%
Not applicable	22	13.0%
I do not know	23	13.6%
Other	31	18.3%
Approximately how often would you prefer these results to be made available?		
Everyday	14	8.3%
Once a week	25	14.8%
Once a month	89	52.7%
Once every 6 months	16	9.5%
Once a year	4	2.4%
Not applicable	6	3.6%
I do not know	4	2.4%
I do not want the results to be made available	2	1.2%
Other	6	3.6%
How often do you undergo an overall performance evaluation?		
Once a month	4	2.4%
Once every 3 months	22	13.0%
Once every 6 months	17	10.1%
Once a year	91	53.8%
Never	16	9.5%
I do not know	8	4.7%
Not applicable	3	1.8%
Other	7	4.1%
Do you participate in any continuing medical education (CME) activities?		
Yes	134	79.3%
No	7	4.1%

multitude of factors, including: training; identifying knowledge gaps; accountability and responsibility; patient safety and overall improvement.

Disadvantages of an inappropriate, ineffective system

There was a general understanding of the disadvantages of an inappropriately designed or utilised quality system. It was highlighted that such systems may potentially be open to corruption, or at a more individual level, demotivate and demoralise staff, and lead to behavioural changes as a result.

Discussion

Despite a relatively poor knowledge of organisational-specific quality systems, the general understanding of the core components and importance of these systems was demonstrated on multiple levels. The role of quality systems in the LMICs was well supported, where the essential barriers and facilitators for these systems was found to be similar to that reported in the literature.

Knowledge

The importance of system structure, and its understanding has been previously highlighted as a factor supporting the implementation of quality systems in healthcare.[17] In this study with a focus on the LMICs, there was poor knowledge of organisational-specific systems among participants surveyed. Despite this lack of knowledge, there was a desire to improve this understanding, supported during the interviews when participants demonstrated an understanding of the core attributes and characteristics of quality assessment in general.

Attitude

Organisational culture, and the importance of effective and engaged leadership were identified in this study as important strategic determinants for success, two factors previously reported to play a central role in achieving efficient quality

TABLE 4. *Continued*

	n	%
I do not know	0	0.0%
Not applicable	0	0.0%
Not answered	28	16.6%
Which of the following best represents the criteria for how you select which CME topic/subject to participate in (may be multiple)		
The topic is easy	6	3.6%
The topic is one I enjoy/find interesting	108	63.9%
The topic is one I do not know a lot about	87	51.5%
A quality review revealed that I performed poorly in the topic	75	44.4%
In order to retain Board registration	17	10.1%
There are few options available, I select what I have access to	34	20.1%
Other	2	1.2%
Not applicable	0	0.0%
Not answered	28	16.6%

management.[17,18] Furthermore, there was significant commentary that emerged through interview participants' recognition of the historical connotations and stigma surrounding previous failed or ineffective quality systems, and the barrier they represent. This association was often discussed in conjunction with the general perception that these systems were often punitive in nature, with too much focus on assigning individual blame. The notion of a 'blame-culture' has previously been identified as a factor that discourages the reporting of adverse events and near misses both in healthcare in general and EMS specifically.[18,19]

Linked to this, was the importance of leadership towards changing organisational mindset and correcting the negative stigmas. To facilitate this, communication in particular emerged as a recurring feature among several of the categories identified. Its role in implementation, facilitating staff engagement through awareness and the sharing of information and ideas was found to be essential.

Practices

From a more pragmatic focus, many of the components necessary to ensure success, reported in the literature, were also identified in this study.[18,20] Issues surrounding transparency, consistency and reproducibility were initially highlighted in the survey. Validity and reliability similarly emerged during the interviews, all points previously identified as fundamental in EMS performance measurement.[20]

The emphasis on context was attributed to not only the disparities seen in private *versus* government-funded services, but in geographical variation as well. The need to have locally relevant and appropriate measures and

TABLE 5. *Qualitative exploration of the knowledge, attitude and practices (KAP) of clinical quality and performance assessment among South African trained ALS EMS personnel*

Sub-category	Category	Supporting quote
An essential component of healthcare (K) Used as a monitoring tool (K, P) Should be measured against a standard (K, P) Relevant to the low resource/low- to middle-income country setting (A) High quality care should always be expected from staff (A)	General understanding of quality assessment	*'I think it's very important, and I will give you a little example of why I think it's important. So, when you think of somebody who is rich and somebody who is poor, if you go to somebody's house and the house is dirty, and let us say they are sort of lower income, keeping a house clean does not take a lot of money, or minimal. It's about a level of quality of cleanliness, if you understand what I'm saying? So just because somebody's poor, does not mean they should not be clean. So, it's the same sort of thinking, … organisations that are resource limited can still achieve a reasonable sense of quality without all the fancy resources and fancy equipment. It comes down to basic needs of the patient. Yes, I think quality can be maintained, no matter how resource poor any institution or organisation is'.*[2] *'So basically, I feel, even in a resource limited setting, I do see the need and requirement for an audit tool of some form, because then we can further see what we are doing, is it right, wrong, or are we incurring harm or are we worsening cases?'*[5]

TABLE 5. *Continued*

Sub-category	Category	Supporting quote
Quality system should be tailored to local setting/take local circumstances into account (K, A) Quality system should take into account private *versus* government service organisational variation (K, A) Quality system should take into account provincial and rural *versus* urban geographical variation (K, A, P)	The role of context in quality assessment	*'I would say that to improve uptake and acceptance, one would need to make it contextually appropriate and relevant and almost be localised adaption at provincial level or lower, but it still aligns itself to a greater set of criteria that is whatever methodology behind it or robustness behind it'.*[21] *'No, because if you are going to say that the Western Cape is resource limited, Cape Town central is not the same resource limited that is out in Northern Cape, in Kathu. So out in Kathu they have got one ambulance, so firstly from a human resource point of view they are resource limited. In Cape Town central, in my division, so in one division in Cape Town central, which is the western division, they have got four ALS on every shift'.*[20] *'There is financial motivation. If they do not make sure that their quality is up to standard, then they lose the contracts that they have with medical aids, and then their finances get affected'.*[8] *'From discussions I've had with private sector paramedics, they are more stringent in private sector, because private sector is, my view is that they are finance driven and if they do not put in information or they do not treat a patient in a certain way, they get penalised. So, the private sector, I think are more tight, in my opinion, on quality processes'.*[18]
Communication an essential component of implementation (A, P) Historical perceptions of quality systems a barrier to implementation barrier? (A, P)	Factors affecting implementation of quality assessment systems	*'If you get everyone to understand what benefit is there to their patients and what benefit is there to them for doing it, then it can be successful… it does not need to be a financial benefit. If I knew as a practitioner that if I took part in a clinical governance process, then I would confidently know that I'm giving the best possible care to my patients, you'd have my buy-in straight away'.*[6] *'There definitely needs to be an interactive system, a one sided "review cases and then slap him down when there a poor interaction" is not particularly valuable. We've always focused on the disciplinary use of it and the corrective portion rather than the encouraging the good'.*[9] *'Perhaps because of the way that it's been managed in the past, where people have had negative experiences, when it becomes a case of let us just tell you no, no, no, this is not how you do it'.*[3]
Effective leadership has central role to play in quality system (A, P) Maintain open sharing of information and ideas with staff to ensure success (A, P) Awareness and understanding among staff key to buy in (A, P) Quality assessment should be priority within any organisation (A) Quality system important to public perceptions/ expectations (A)	Factors affecting ongoing utilisation of quality assessment systems	*'So, we do have bad apples, but as a whole, if you ask one of the top managers, what is your culture around dealing with mistake/medical error as such, they should be telling you that it is just culture. Now, if someone says that already, then at least you are somewhere. And I like the saying, culture trumps policy every time. We can have whatever policy we have'.*[20] *'… to properly implement it, you are going to need appropriate management, and you are going to need management that actually wants to. And in my opinion, I think we have a lot of management that is there simply because they can be there, and not because they take it at heart'.*[14]

TABLE 5. *Continued*

Sub-category	Category	Supporting quote
Culture that supports staff is essential (A)		
Results of quality system should be used appropriately (A)		
Quality system should be objective and transparent (A)	Quality assessment system reliability and validity	*'…because the staff on the ground are intimately part of improvements. In fact, they are the key role players, so they should know exactly what the targets are, they should know exactly how it's being measured, so they are clear on what the expectations are'.*[2]
Quality system should be consistent in its utilisation and reporting (A)		*'If people can understand what you are doing and why you are doing it, you are going to have their buy-in a lot more than just by saying this is what we are doing and you are going to have to accept it. I think they would want to know, and also if you know why it's being done, you probably would not be so sceptical about it or so nervous about it. You would probably embrace it a lot more and understand it'.*[10]
Quality system should encourage peer support (A, P)		
Effective quality system ensures patient safety (A)	Advantages of an effective, efficient quality assessment system	*'So, I think if there was a standard thing implemented it would be huge for patient care, because I think they would pick up problems that they could actually fix for sure, and then I think it would help the staff to just stay more on top of things as a whole as well. I think, also knowing that their care is being watched closer would also prompt people to stay more current and attend more training, do you know what I mean? Like stay on top of things themselves also, because I think that people do get quite complacent there because they are kind of just left to just do what they like'.*[14]
Effective quality system identifies knowledge gaps (A)		*'You know, we have only now recently started moving over to looking at quality indicators of positive things, things that we are doing well, instead of only looking at adverse events as quality – or saying we now only have – we have done 100 cases and we only had two reported adverse events. Where now, we are starting to look it actually good things as well'.*[20]
Effective quality system ensures implementation of best care/evidence-based care (A)		
Effective quality system facilitates improvement in delivery and quality of clinical care (A)		
Effective quality system optimises use of available resources (A)		
Effective quality system facilitates staff and organisational responsibility and accountability (K, A)		
Inappropriate quality system open to corruption (A, P)	Disadvantages of an inappropriate, ineffective quality assessment system	*'And then I think of course that many people in our organisation fear the governance, because they are scared that someone is going to shout at them, they are going to look like an idiot in front of their peer, and I think in that way they probably do not understand what we are trying to achieve and what we are doing. And then some people are also actively against clinical governance, because I am an independent practitioner, so why are you governing me? I got my degree, or I have my diploma or my certificate, you should not govern me, there's no reason for that'.*[16]
Punitive-based quality system leads to behavioural change in staff (A, P)		*'…that's where I think it can be a dangerous thing, because you might get people who come and just do what they have to do, just because they want the points, instead of doing it for the best interest in your service and your patients. I think because you do not want people to do something because they are going to get something out it'.*[10]
Punitive-based quality system demotivates and demoralises staff (A)		

standards was perceived to be a facilitator of success not only in SA, but the broader LMICs. The importance of context, both in accounting for local settings when designing systems and measures, and in sustaining their utilisation have becoming increasingly recognised as central to overall success in the LMICs.[21–24]

Despite initially intending to gain a deeper understanding of quality systems among South African PEC practitioners, much of the results of this study echo that found in the literature from a variety of healthcare fields and settings. There is the potential that these results may be of value to PEC services across a variety of settings and contexts, looking to improve staff buy-in and participation with their quality system.

Limitations

The purpose of the study was not to infer association or correlation from the survey results. Priority in this sequential explanatory design was placed on the qualitative component, from the outset. As a result, the survey component served to provide a baseline understanding of the subject matter, and act as a guide to further explore the results during the interview phase.

EMS practitioners are increasingly taking up new, emerging roles within healthcare and in the community.[25–28] We attempted to obtain a broad understanding of quality systems among practitioners across these roles. It is likely that variation exists within these specific roles and remains an area for future research. Similarly, while healthcare in SA shares several attributes common to health systems across the LMICs, variations in the understanding of quality systems among EMS practitioners across the LMICs may too potentially exist.

The primary aim of the research was to identify the 'understanding' of quality systems, from the individual practitioners perspective, as a precursor to improving such systems. This study does not take into account an organisation's role towards improving and facilitating an effective quality system, and remains an avenue for future research.

Conclusion

The knowledge of specific organisational quality systems was found to be poor among participants in the present study. Despite this, there was a strong general understanding of the importance of quality systems, and their potential role within the LMIC setting. Furthermore, core attributes central to the successful design and implementation of effective quality systems found in the literature, were equally identified in this study and remain equally important towards the success of quality systems in the LMICs.

Author contributions

IH, VL, PC, LW, MC conceived the study. IH conducted the data collection and analysis. IH drafted the manuscript, and all authors contributed substantially to its revision. All authors take responsibility for the paper.

Competing interests

None declared.

References

1. GBD 2016 Healthcare Access and Quality Collaborators. Measuring performance on the Healthcare Access and Quality Index for 195 countries and territories and selected subnational locations: a systematic analysis from the Global Burden of Disease Study 2016. *Lancet* 2018; **391**: 2236–71.
2. National Academies of Sciences; Engineering and Medicine. *Crossing the Global Quality Chasm: Improving Health Care Worldwide*. Washington, DC: National Academies Press, 2018.
3. Barber RM, Fullman N, Sorensen RJD *et al*. Healthcare Access and Quality Index based on mortality from causes amenable to personal health care in 195 countries and territories, 1990–2015: a novel analysis from the Global Burden of Disease Study 2015. *Lancet* 2017; **390**: 231–66.
4. Kruk ME, Gage AD, Arsenault C *et al*. High-quality health systems in the sustainable development goals era: time for a revolution. *Lancet Glob. Health* 2018; **6**: e1196–252.
5. The World Bank. World Bank Country and Lending Groups Country Classification. 2018. [Cited 20 Feb 2019.] Available from URL: https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups
6. Pillay-van Wyk V, Msemburi W, Laubscher R *et al*. Mortality trends and differentials in South Africa from 1997 to 2012: second National Burden of disease study. *Lancet Glob. Health* 2016; **4**: e642–53.
7. Department of Health. A policy on quality in health care for South Africa. Department of Health, Republic of South Africa. 2007.
8. Health Professions Council of South Africa Professional Board for Emergency Care. Guidelines for the Completion of the Portfolio for Institutions Wishing to Offer the ECT and ECP Programs. Pretoria, 2011.
9. Ivankova NV, Creswell JW, Stick SL. Using mixed-methods sequential explanatory design: from theory to practice. *Field Methods* 2006; **18**: 3–20.
10. Health Professions Council of South Africa Professional Board for Emergency Care. *Advanced Life Support Practitioner Protocol*. Pretoria: Government Press, 2006.
11. World Health Organization. *A Guide to Developing Knowledge, Attitude and Practice Surveys*. Geneva: World Health Organization, 2008; 1–68.
12. Kaliyaperumal K. Guideline for conducting a knowledge, attitude and practice (KAP) study. *Commun. Ophthalmol.* 2004; **4**: 7–9.
13. Onwuegbuzie AJ, Collins KMT. A typology of mixed methods sampling designs in social science research. *Qual. Rep.* 2007; **12**: 281–316.
14. Fetters MD, Curry LA, Creswell JW. Achieving integration in mixed methods designs - principles and practices. *Health Serv. Res.* 2013; **48**: 2134–56.

15. Hseih H-F, Shannon SE. Three approaches to qualitative content analysis. *Qual. Health Res.* 2005; **15**: 1277–88.
16. Graneheim UH, Lindgren B-M, Lundman B. Methodological challenges in qualitative content analysis: a discussion paper. *Nurse Educ. Today* 2017; **56**: 29–34.
17. Wardhani V, Utarini A, van Dijk JP, Post D, Groothoff JW. Determinants of quality management systems implementation in hospitals. *Health Policy (New York)*. 2009; **89**: 239–51.
18. Fairbanks RJ, Crittenden CN, O'Gara KG *et al*. Emergency medical services provider perceptions of the nature of adverse events and near-misses in out-of-hospital care: an ethnographic view. *Acad. Emerg. Med.* 2008; **15**: 633–40.
19. de Vos ML, van der Veer SN, Graafmans WC *et al*. Implementing quality indicators in intensive care units: exploring barriers to and facilitators of behaviour change. *Implement. Sci.* 2010; **5**: 52.
20. Moore L. Measuring quality and effectiveness of prehospital EMS. *Prehosp. Emerg. Care* 1999; **3**: 325–31.
21. Leatherman S, Ferris TG, Berwick D, Omaswa F, Crisp N. The role of quality improvement in strengthening health systems in developing countries. *Int. J. Qual. Health Care* 2010; **22**: 237–43.
22. Bhattacharyya O, Mossman K, Ginther J *et al*. Assessing health program performance in low- and middle-income countries: building a feasible, credible, and comprehensive framework. *Glob. Health* 2015; **11**: 51.
23. Kruk ME, Larson E, Twum-Danso NAY. Time for a quality revolution in global health. *Lancet Glob. Health* 2016; **4**: e594–6.
24. Akachi Y, Kruk ME. Quality of care: measuring a neglected driver of improved health. *Bull. World Health Organ.* 2017; **95**: 465–72.
25. O'Meara PF, Tourle V, Stirling C, Walker J, Pedler D. Extending the paramedic role in rural Australia: a story of flexibility and innovation. *Rural Remote Health* 2012; **12**: 1–13.
26. Stirling CM, O'Meara P, Pedler D, Tourle V, Walker J. Engaging rural communities in health care through a paramedic expanded scope of practice. *Rural Remote Health* 2007; **7**: 839.
27. Woollard M. The role of the paramedic practitioner in the UK. *J. Emerg. Prim. Heal. Care* 2006; **4**: 1–9.
28. Cooper S, Grant J. New and emerging roles in out of hospital emergency care: a review of the international literature. *Int. Emerg. Nurs.* 2009; **17**: 90–8.

African Journal of Emergency Medicine 9 (2019) 185–192

Contents lists available at ScienceDirect

African Journal of Emergency Medicine

journal homepage: www.elsevier.com/locate/afjem

ORIGINAL ARTICLE

Identifying quality indicators for prehospital emergency care services in the low to middle income setting: The South African perspective

Ian Howard[a,b,*], Peter Cameron[c], Lee Wallis[b], Maaret Castrén[d], Veronica Lindström[e]

[a] Department of Clinical Science and Education, Södersjukhuset, Karolinska Institutet, Stockholm, Sweden
[b] Division of Emergency Medicine, Stellenbosch University, Stellenbosch, South Africa
[c] School of Public Health and Preventive Medicine, Monash University, Melbourne, Australia
[d] Department of Emergency Medicine and Services, Helsinki University Hospital, Helsinki University, Helsinki, Finland
[e] Department of Neurobiology, Care Sciences, and Society, Division of Nursing, Karolinska Institutet, Academic EMS, Stockholm, Sweden

ARTICLE INFO

Keywords:
Emergency medical service
Quality indicators
Patient safety
South Africa

ABSTRACT

Introduction: Historically, performance within the Prehospital Emergency Care (PEC) setting has been assessed primarily based on response times. While easy to measure and valued by the public, overall, response time targets are a poor predictor of quality of care and clinical outcomes. Over the last two decades however, significant progress has been made towards improving the assessment of PEC performance, largely in the form of the development of PEC-specific quality indicators (QIs). Despite this progress, there has been little to no development of similar systems within the low- to middle-income country setting. As a result, the aim of this study was to identify a set of QIs appropriate for use in the South African PEC setting.

Methods: A three-round modified online Delphi study design was conducted to identify, refine and review a list of QIs for potential use in the South African PEC setting. Operational definitions, data components and criteria for use were developed for 210 QIs for inclusion into the study.

Results: In total, 104 QIs reached consensus agreement including, 90 clinical QIs, across 15 subcategories, and 14 non-clinical QIs across two subcategories. Amongst the clinical category, airway management (n = 13 QIs; 14%); out-of-hospital cardiac arrest (n = 13 QIs; 14%); and acute coronary syndromes (n = 11 QIs; 12%) made up the majority. Within the non-clinical category, adverse events made up the significant majority with nine QIs (64%).

Conclusion: Within the South Africa setting, there are a multitude of QIs that are relevant and appropriate for use in PEC. This was evident in the number, variety and type of QIs reaching consensus agreement in our study. Furthermore, both the methodology employed, and findings of this study may be used to inform the development of PEC specific QIs within other LMIC settings.

African relevance

- Development of prehospital emergency care quality systems has been poor in Africa.
- Measuring quality of care is highly contextual.
- There are a multitude of quality indicators that are appropriate for use in Africa.

Introduction

Historically, performance within the Prehospital Emergency Care (PEC) setting has been assessed primarily based on response times. While easy to measure and valued by the public, overall, response time targets are a poor predictor of quality of care and clinical outcomes outside of a small subset of patients [1–3]. Over the last two decades however, significant progress has been made towards improving the assessment of PEC performance, largely in the form of the development of PEC-specific quality indicators (QIs) [4–6]. QIs are designed to measure "the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge" [7]. Despite this progress, the development of these systems has largely been confined to services within North America and Europe, with little to no development of similar systems evident within the low- to middle-income country (LMIC) setting [6].

Compared to a high-income country setting, the development of

* Corresponding author at: Department of Clinical Science and Education, Södersjukhuset, Karolinska Institutet, Stockholm, Sweden.
E-mail address: ian.howard@ki.se (I. Howard).

https://doi.org/10.1016/j.afjem.2019.07.003
Received 19 February 2019; Received in revised form 18 April 2019; Accepted 24 July 2019
Available online 06 August 2019

quality systems within LMICs is arguably of greater importance, as insufficient quality of care is now perceived to be a bigger barrier to reducing mortality than insufficient access, with an estimated 60% of deaths from conditions amenable to healthcare, due to poor quality care in LMICs [8–11]. Despite this, emergency care has an important role to play in LMICs, where it has been estimated that up to 45% of deaths and 36% of all disability-adjusted life years are potentially amenable to secondary prevention via prehospital and in-hospital emergency care [12,13]. It stands to reason therefore that the development of quality systems and indicators aimed at improving and optimising care in this setting could have a significant potential impact on this burden.

Healthcare in South Africa (SA) shares several attributes common to health systems across LMICs [14]. Recent Department of Health policy reviews have similarly highlighted the importance of systems for developing, implementing and monitoring the quality of healthcare in SA [15]. Within the PEC setting, significant advances have been made towards improving the scope of practice, and training and education of PEC clinicians. However, little is known regarding the quality and performance delivered by these services in this setting.

Several similarities in scope of practice exist between the South African PEC services and other services within a high-income country setting [16–19]. Despite this, measures of quality and performance may not be equally appropriate across settings, given the differences in service use, structure, resource availability and deployment, and education and training of clinicians. As a result, the aim of this study was to identify a set of clinical quality indicators appropriate for use in the South African PEC setting, with implications for extrapolation to LMICs.

Methods

A three-round modified online Delphi study design was used to identify, refine and review a list of QIs for potential use in the South African PEC setting. This included both the consensus agreement on the appropriateness of QIs identified in the literature, and the development of QIs amongst an expert panel.

Literature review and quality indicator advisory group

A previous review of the literature identified several potential QIs for use in this study [6], a common starting point for the consensus rating of healthcare QIs [20]. The review mapped the extent, range and nature of the scientific literature regarding prehospital QIs, with a focus on methodological development and QI components necessary for implementation. The majority of the QIs identified lacked sufficient definition, data components and/or criteria for use. Therefore, in order to operationalise the indicators, a QI Advisory Group, consisting of five experts in prehospital quality assessment, was assembled to further refine the identified QIs for inclusion in this Delphi study. The QI Advisory Group consisted of a combination of SA and international emergency care practitioners with specific training in prehospital quality assessment and quality improvement. Guidelines outlined by Rubin et al., McGlynn et al., and Mainz were used to develop relevant definitions and criteria for each QI [7,21,22]. Table 1 outlines the template developed for use by the group (Supplementary data includes a full description and data dictionary of the final indicator set).

Operational definitions, data components and criteria for use were developed for 210 QIs by the QI Advisory Group. These were categorised into one of two categories; Clinical - QIs that assessed a specific intervention, or were dependent on the presence/absence of a disease or injury characteristic (e.g., vital signs, symptoms, or treatment administered); and Non-clinical - QIs that primarily focused on an aspect of service delivery (e.g., resource utilisation or documentation). Within each category, the QIs were further divided by subcategory: clinical pathway for Clinical QIs (n = 19 subcategories, 134 QIs); or by area of service for those QIs categorised as Non-clinical (n = 8 subcategories, 76 QIs). The categorisation was included to align with and allow for the easier implementation of the QIs into practice, as the PEC focused Clinical Practice Guidelines in SA are similarly based around broad diagnoses and/or symptom presentations [16]. Lastly, each of the QIs were classified according to Donabedian's classification of healthcare information and data, to further aid in identifying their role and purpose [23]:

- Structure measures denote the attributes of the setting in which health care occurs, and primarily includes material resources (e.g., facilities, equipment, and financing), human resources, and organisational structure;
- Process measures denote the steps in the actual delivery of health care (i.e., what the health care provider does to maintain or improve health; e.g., making a diagnosis or recommending/implementing treatment);
- Outcome measures denote the effects or impact of care on the health status of patients and/or populations (i.e., changes in a patient's health status that could be attributed to antecedent care).

Modified/Online Delphi

Purposeful sampling was used to ensure appropriate experts were invited to participate due to the focus on both SA PEC and LMICs [20,24,25]. Given that emergency care focused quality assessment is new to SA, the pool of experts with sufficient knowledge and experience was limited. As a result, the range of potential participants invited was expanded to include: emergency medicine physicians, emergency care nurses, and prehospital emergency care practitioners with a wide

Table 1
Quality indicator (QI) development template.

Definition	Basic description/purpose of the QI
Category	Primary area of focus of the QI
Subcategory	Secondary area, within the Category that the QI is focused
Measure Type	Structure, process or outcome
Target Population	Population on whom the quality indicator is measured/applied
Unit of Analysis	Service component under study/assessment for quality and performance
Numerator Statement	Description of the subset of the subcategory population on whom the quality indicator is measured/applied
Denominator Statement	Description of the subcategory level of population on whom the quality indicator is measured/applied
Case Mix/Risk Adjustment	Suggested differentiation amongst the denominator population for greater accuracy (i.e., stratification)
Exclusion Criteria	Denominator cases to be excluded when applying the QI
Measure Calculation	The equation for calculating the QI
Numerical Reporting Format	Suggested format in which the numerical results should be reported
Graphical Reporting Format	Suggested format in which the results should be displayed/visualised
Reported Indicator	Suggested output in which results should be described
Data Source	Suggested data source to obtain the data required for calculating the QI
Suggested Reporting Period	Time frame, number of successive cases or other grouping strategies cases should be aggregated for reporting purposes
Recommended Review Period	Suggested time period at which the QI should be reviewed for validity and feasibility

Table 2
Expert panel demographics (N = 35).

Demographics	n	(%)
Healthcare background		
Paramedic	26	(74)
Nurse	2	(6)
Physician	7	(20)
Gender		
Male	23	(66)
Female	12	(34)
Location		
South Africa	28	(80)
International	7	(20)

variety of primary occupations, including: operations and clinical care, education and training, management, and quality assurance. In addition, given the focus on LMICs, international experts with prior experience in LMICs and with knowledge of emergency care focused quality assessment, were additionally considered as experts. Criteria for inclusion into the expert panel included those with a background in the above-mentioned fields, with preference given to potential participants who had one or more of the following: post-graduate qualification in prehospital or emergency care, previous experience in quality assessment and/or quality improvement, were employed either part-time or full-time in quality assessment or quality improvement at the time of the study, or had previous experience in working in emergency care in either SA and/or an LMIC. In total, 45 participants were contacted regarding potential participation in the study. Of this group, 35 participants agreed to participate prior to the start of Round 1 (Table 2).

The Delphi process was modified in this study in that each round was conducted online, and all correspondence was conducted electronically. No face-to-face consensus meetings were held [20,24,25]. The foci for each of the Delphi rounds were as follows:

- Round 1: Agreement of QI subcategories. Consensus rating on the subcategories was initially sought to provide focus for the specific QIs to be presented in Round 2, as opposed to presenting all candidate QIs for rating in the first round [26].
- Round 2: Presentation of QIs from participant selected subcategories. The individual QIs from the respective QI subcategories identified in Round 1 were presented for rating in Round 2.
- Round 3: Representation of QI subcategories without consensus, individual QIs without consensus, and agreement of participant-proposed QIs. QIs that not did reach consensus approval in Rounds 1 and 2 were re-presented for rating in Round 3. Participant proposed QIs from Round 2 were additionally presented for rating.

Prior to the start of the Delphi, participants were sent information about the study and access to round 1 of the Delphi. For each subsequent round, the participants were sent a group summary of the previous round's output, as well as requirements for the subsequent round. For each round, participants were given the opportunity to propose additional QI categories and/or QIs for subsequent rounds.

For each round, participants were required to rate their level of agreement for the respective QI subcategories and QIs based on a 5-point Likert scale, ranging from strongly disagree (1) to strongly agree (5). To achieve consensus agreement, at least 70% of participants had to rate a QI subcategory or individual QI in the “agreement” range of scores (4 or 5). QI subcategories and individual QIs that achieved consensus agreement were not reiterated in subsequent rounds. QI subcategories and individual QIs that did not reach consensus agreement, and participant proposed QIs were refined based on feedback and suggestions and included in subsequent rounds for consensus rating. Data collection was considered concluded when each QI subcategory and individual QI had been evaluated via a consensus round by the panel of experts; and those in which no consensus could be reached were evaluated via a second round to allow participants the opportunity to potentially amend their previous rating.

Summaries of each round were distributed via email. Data for the consensus rating were collected using an online survey tool - Checkbox (Checkbox Survey Solutions, Massachusetts, USA, 2017), and collated and analysed using Microsoft Excel 2010 (Microsoft Corp, Richmond, WA). All data were analysed using univariate descriptive statistics to describe the Likert ratings of each Delphi round.

Ethical approval to conduct the study was granted by the University of Stellenbosch Health Research Ethics Committee (Ref no. S15/09/193).

Results

Round 1 achieved a 97% response rate (n = 34). Table 2 describes the expert panel demographics. Of the 28 subcategories proposed, ten Clinical subcategories and two Non-clinical subcategories reached consensus agreement amongst respondents. The proposed individual QIs from these subcategories went on to Round 2 for consensus agreement. The subcategories and their respective individual QIs not achieving consensus were re-presented in Round 3 to allow respondents to amend their choice from Round 1 (Fig. 1).

Round 2 achieved an 86% response rate (n = 30). Within the ten clinical subcategories achieving consensus agreement in Round 1, 94 individual clinical QIs were proposed in Round 2, with 68 (72%) reaching consensus agreement amongst respondents. For the 2 non-clinical subcategories reaching consensus agreement in Round 1, 19 individual non-clinical QIs were proposed, with 12 (63%) reaching consensus (total reaching consensus, n = 80).

The response rate for Round 3 was 83% (n = 29). The QIs from the subcategories of Round 1 that did not reach consensus agreement, the remaining individual QIs from Round 2 that did not reach consensus, and the newly proposed QIs resulting from Round 2 were all presented in Round 3. Four new QIs were proposed, three clinical, and one non-clinical, of which one clinical and one non-clinical reached consensus agreement. For Round 3, in total, five of the subcategories that had not reached consensus in Round 1 reached consensus agreement, all within the clinical category. Twenty-two clinical QIs and two non-clinical QIs that had not reached consensus in Round 2, were accepted by consensus in Round 3.

In total, 104 individual QIs reached consensus agreement by the end of the Delphi study, 90 clinical QIs across 15 subcategories and 14 non-clinical QIs across two subcategories. Within the clinical category, airway management [n = 13 QIs (14%)]; out of hospital cardiac arrest (OHCA) (n = 13 QIs; 14%); and acute coronary syndromes (ACS) (n = 11 QIs; 12%) made up over a third of this category (Table 3). Within the non-clinical category, adverse events made up the significant majority with nine individual QIs (64%) (Table 4). The majority of QIs not reaching consensus agreement were found in the non-clinical category (n = 62 QIs), with time intervals (n = 15 QIs) and documentation (n = 13 QIs) making up the majority. Within the clinical subcategories not reaching consensus, the management of tachyarrhythmias (n = 5 QIs) and the management of bradyarrhythmias (n = 4 QIs) made up the majority.

In terms of Donabedian's classification of healthcare information and data, within the final list of individual QIs, there were a total of ten (10%) structure-based QIs, 83 (80%) process-based QIs, two (2%) outcome-based QIs, and a further nine (8%) QIs categorised as sentinel events, given their specific focus on patient safety.

Quality systems in the PEC setting are in their infancy in SA. As a result, the pool of available experts for participation was smaller than would be expected in a country with more formal and advanced quality systems. The potential exists that participants with increased exposure and experience within these formal quality systems may have reached consensus agreement on a different set of indicators than that reported

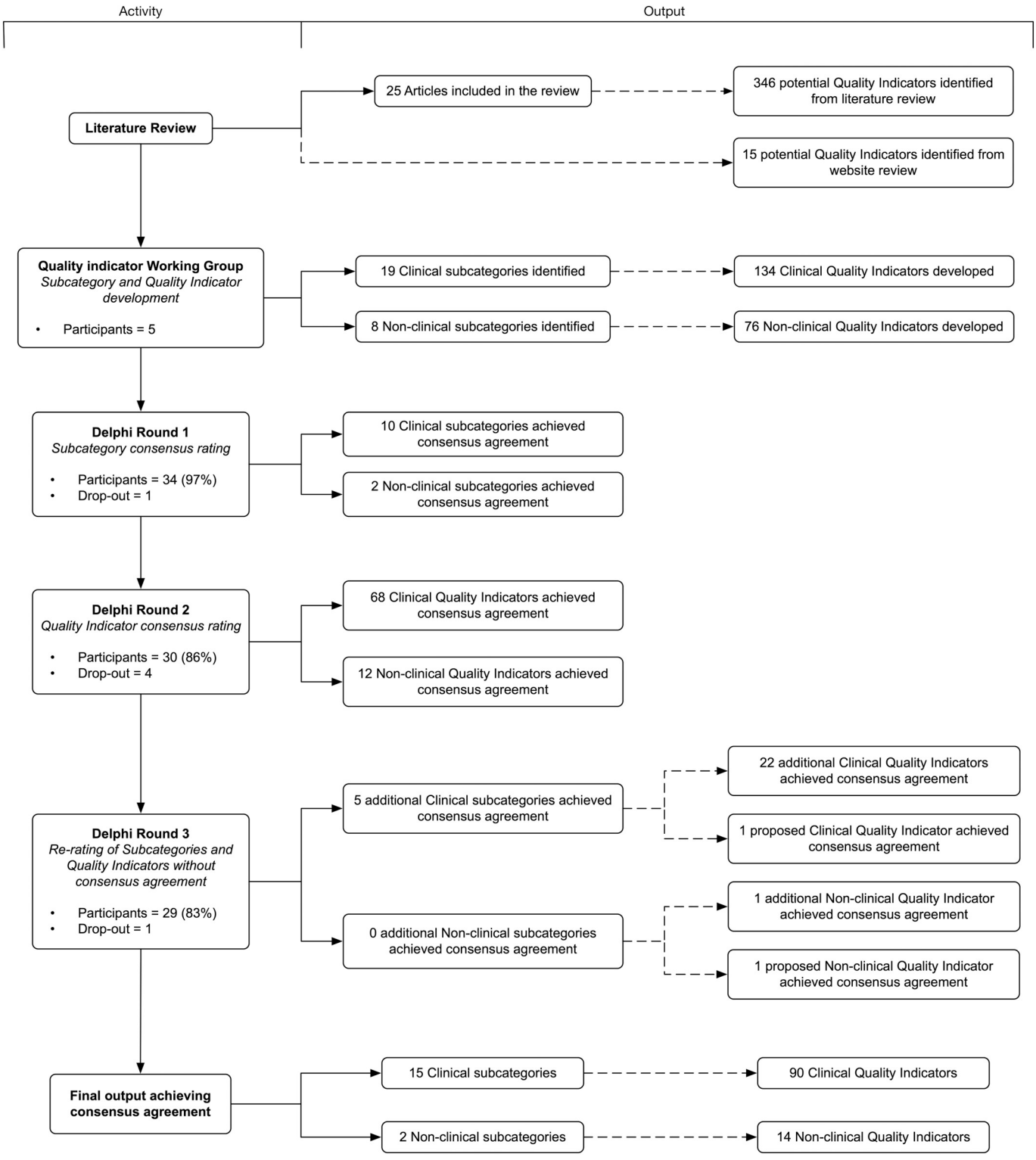


Fig. 1. Delphi rounds and output.

in this study. Despite this, the number and proportion of participants continuing through each round remained within the bounds of what is considered acceptable for a Delphi study for identifying QIs within healthcare [20]. Furthermore, such heterogeneity in the expert panel has previously been identified as an advantage towards decision making in the consensus rating process [27].

The study was facilitated entirely online with all correspondence conducted electronically via email. It is arguable that this approach limits response rates and the benefits of face-to-face contact, such as the real-time exchange of information [28]. Conversely however, this approach avoids the situation that would allow any single panel member from dominating the consensus process, a potential possibility in a physical metting of experts [28].

The focus for this study was on the identification of QIs appropriate for the SA setting, using QIs previously described in the literature. While opportunity was provided for participants to describe new QIs

Table 3
Clinical category – QIs reaching consensus agreement.

Subcategory type	Applicable scope of practice			QI classification	Mean	SD	Round
	BLS	ILS	ALS				
ACS/STEMI subcategory							
Patients with a provisional diagnosis of ACS/STEMI who had an ALS practitioner in attendance			X	Process	3.7	1.3	2
Patients with a provisional diagnosis of ACS/STEMI who had a set of defined cardiac risk factors assessed and recorded		X	X	Process	3.8	1.1	3
Patients with a provisional diagnosis of ACS/STEMI who had a 12 lead ECG obtained		X	X	Process	4.3	1.1	2
Patients with a provisional diagnosis of ACS/STEMI who were administered Aspirin	X	X	X	Process	4.7	0.6	2
Patients with a provisional diagnosis of ACS/STEMI who were administered GTN		X	X	Process	3.9	1.1	2
Patients with a provisional diagnosis of ACS/STEMI who were assessed for suitability for thrombolysis by defined checklist		X	X	Process	4.0	1.3	2
Patients with a provisional diagnosis of ACS/STEMI who were administered prehospital thrombolysis			X	Process	3.8	1.4	3
Patients with a provisional diagnosis of ACS/STEMI who were transported directly to a Facility with PCI capabilities	X	X	X	Process	4.5	0.9	2
Patients with a provisional diagnosis of ACS/STEMI who had EMS activation of the receiving Cath Lab	X	X	X	Process	4.0	1.2	2
Patients who received/met all components of a defined ACS/STEMI composite bundle score			X	Process	4.2	1.1	2
Acute Pulmonary Oedema subcategory							
Patients with a provisional diagnosis of APO who were administered GTN		X	X	Process	4.3	1.0	3
Patients with a provisional diagnosis of APO who received CPAP			X	Process	3.9	1.0	3
Patients with a provisional diagnosis of APO who had a 12 lead ECG obtained		X	X	Process	4.3	1.0	3
Airway Management subcategory							
Patients who received a pre-ETI paralytic, following which there was a decrease in SpO2 > 10% from baseline/or decrease below 70% overall			X	Process	3.9	1.2	2
Patients successfully intubated by EMS personnel where EtCO2 monitoring was used post ETI			X	Process	4.8	0.5	2
Patients successfully intubated via RSI by EMS personnel where a paralytic agent was administered post-ETI			X	Process	4.1	1.1	2
Patients successfully intubated by EMS personnel where a sedative agent was administered post-ETI			X	Process	4.5	0.8	2
Patients successfully intubated by EMS personnel where a mechanical ventilator was used post-ETI for ventilation			X	Process	4.5	0.7	2
Patients in whom ETI was attempted by EMS personnel who had an alternative airway inserted as a final airway			X	Process	4.4	1.0	2
Patients in whom ETI was attempted by EMS personnel who had a surgical airway inserted			X	Process	4.3	1.2	2
Patients successfully intubated by EMS personnel with an EtCO2 < 30 mmHg or >50 mmHg post-ETI >10 min during EMS care			X	Process	4.2	1.2	2
Patients in whom RSI with ETI was unsuccessful when attempted by EMS personnel			X	Process	4.4	1.1	2
Patients in whom Non-RSI ETI was unsuccessful when attempted by EMS personnel			X	Process	4.3	1.2	2
Patients in whom RSI with ETI was successful when attempted by EMS personnel			X	Process	4.4	1.0	2
Total number of patients successfully intubated via RSI by EMS personnel			X	Process	4.3	1.1	2
Patients who received/met all components of the defined Airway management composite Bundle score			X	Process	4.4	1.0	2
Anaphylaxis subcategory							
Patients with a provisional diagnosis of Anaphylaxis and evidence of bronchoconstriction documented who were administered a B2 agonist		X	X	Process	4.0	1.0	3
Patients with a provisional diagnosis of Anaphylaxis and evidence of bronchoconstriction documented who were administered an Anti-cholinergic bronchodilator		X	X	Process	4.3	1.2	3
Patients with a provisional diagnosis of Anaphylaxis who were administered an antihistamine			X	Process	4.3	1.1	3
Patients with a provisional diagnosis of Anaphylaxis who were administered a corticosteroid			X	Process	4.6	1.1	3
Patients with a provisional diagnosis of Anaphylaxis and signs of a severe systemic response recorded who were administered IM Adrenaline			X	Process	3.8	0.7	3
Asthma/Bronchoconstriction							
Patients with a provisional diagnosis of Asthma/Bronchoconstriction with lung sounds assessed and documented (pre and post treatment)	X	X	X	Process	4.3	1.1	2
Patients with a provisional diagnosis of Asthma/Bronchoconstriction with a SpO2 documented (pre and post treatment)	X	X	X	Process	4.3	1.1	2
Patients with a provisional diagnosis of Asthma/Bronchoconstriction who were administered a B2 agonist bronchodilator		X	X	Process	4.6	0.7	2
Patients with a provisional diagnosis of Asthma/Bronchoconstriction who were administered an anticholinergic bronchodilator		X	X	Process	4.0	1.2	2
Patients with a provisional diagnosis of Asthma/Bronchoconstriction who were administered a corticosteroid			X	Process	4.0	1.3	2
Patients with a provisional diagnosis of Asthma/Bronchoconstriction recorded with documented severe wheezes/silent chest/BP < 90 mmHg systolic BP who were administered IM Adrenalin			X	Process	3.9	1.4	2
Patients who received/met all components of the defined Asthma/Bronchoconstriction composite bundle score			X	Process	4.3	1.1	2
Burns subcategory							
Patients with a provisional diagnosis of Burns with burns dressings applied	X	X	X	Process	4.4	1.3	3
Patients with a provisional diagnosis of Burns with body surface area and burns type assessed and recorded	X	X	X	Process	4.2	0.9	3
General subcategory							
Serviceable suction unit devices available per defined area and/or time period		N/A		Structure	4.1	1.3	2
Serviceable 3 lead ECG monitoring devices available per defined area and/or time period		N/A		Structure	4.2	1.1	2
Serviceable 12 lead ECG monitoring devices available per defined area and/or time period		N/A		Structure	4.3	1.1	2
Serviceable portable oxygen cylinders available per defined area and/or time period		N/A		Structure	4.2	1.1	2
Serviceable Defibrillator/AED devices available per defined area and/or time period		N/A		Structure	4.4	1.1	2

(*continued on next page*)

Table 3 (*continued*)

Subcategory type	Applicable scope of practice			QI classification	Mean	SD	Round
	BLS	ILS	ALS				
Serviceable mechanical ventilators available per defined area and/or time period		N/A		Structure	4.1	1.3	2
Patients with reduced level of consciousness with a blood glucose measured	X	X	X	Process	4.4	1.2	2
Patients with a recorded SpO2 <95% who were administered supplemental Oxygen	X	X	X	Process	3.9	1.4	2
Patients with a provisional diagnosis recorded	X	X	X	Process	3.9	1.4	2
Hypoglycaemia subcategory							
Patients with a blood glucose level <5 mmol who were administered Glucose	X	X	X	Process	4.5	1.1	3
Patients with a blood glucose level measured and recorded following Glucose administration	X	X	X	Process	4.0	0.7	3
Neonate/Paediatric subcategory							
One min APGAR score assessed and recorded for newborn patients	X	X	X	Process	4.5	1.1	2
Five min APGAR score assessed and recorded for newborn patients	X	X	X	Process	4.4	1.1	2
Paediatric patients with a provisional diagnosis of Croup who were administered oral/inhaled steroids			X	Process	3.9	1.1	3
Paediatric patients with a provisional diagnosis of Croup who were administered nebulised Adrenalin			X	Process	3.8	1.3	2
Patient transportation to a facility with specialist Paediatric capabilities/resources	X	X	X	Process	4.2	1.1	2
Obstetrics subcategory							
Obstetric patients who deliver prior to EMS arrival	X	X	X	Process	4.0	1.1	3
Obstetric patients with postpartum haemorrhage who were administered TXA			X	Process	4.5	1.2	3
Obstetric patients with a provisional diagnosis of Eclampsia or Pre-eclampsia who were administered Magnesium sulphate			X	Process	4.2	0.8	3
Obstetric patients who deliver during EMS care	X	X	X	Outcome	4.2	1.2	3
OHCA subcategory							
Patients with a provisional diagnosis of OHCA with a witnessed collapse documented	X	X	X	Process	4.4	1.1	2
Patients with a provisional diagnosis of OHCA who received documented bystander CPR		N/A		Process	4.5	0.9	2
Patients with a provisional diagnosis of OHCA who received documented telephonic CPR advice		N/A		Process	4.1	1.3	2
Patients with a provisional diagnosis of OHCA with VF/VT as first presenting rhythm on arrival of EMS	X	X	X	Process	4.5	1.0	2
Patients with a provisional diagnosis of OHCA with Asystole/PEA as first presenting rhythm on arrival of EMS	X	X	X	Process	4.2	1.2	2
Patients with a provisional diagnosis of OHCA intubated with alternative airway device			X	Process	4.1	1.0	3
Patients with a provisional diagnosis of OHCA for whom resuscitation was cancelled prior to arrival at hospital			X	Process	4.2	1.3	2
Patients with a provisional diagnosis of OHCA who were transported to hospital (incl. ROSC and Non-ROSC patients)	X	X	X	Process	4.1	1.3	2
Patients with a provisional diagnosis of OHCA with ROSC at hospital handover	X	X	X	Process	4.4	1.1	2
Patients with a provisional diagnosis of OHCA with VF/VT at hospital handover	X	X	X	Process	4.1	1.3	2
Patients with a provisional diagnosis of OHCA with Asystole/PEA at hospital handover	X	X	X	Process	3.9	1.4	2
Patients with a provisional diagnosis of OHCA with survival to Emergency Centre discharge	X	X	X	Process	4.4	1.2	2
Patients with a provisional diagnosis of OHCA with survival to hospital discharge	X	X	X	Outcome	4.8	0.8	2
Pain Management subcategory							
Patients with level of Pain measured via defined pain score	X	X	X	Process	4.4	0.8	2
Patients with a defined pain score threshold who were administered analgesia		X	X	Process	4.5	0.7	2
Patients with level of pain measured via defined pain score following analgesia administration	X	X	X	Process	4.5	0.8	2
Seizures subcategory							
Patients with a provisional diagnosis of Seizures with a blood glucose measured and recorded	X	X	X	Process	4.6	0.6	2
Patients with a provisional diagnosis of Seizures who were administered an antiepileptic for ongoing Seizures			X	Process	4.4	0.9	2
Stroke/TIA subcategory							
Patients with a provisional diagnosis of Stroke/CVA/TIA with a blood glucose measured and recorded	X	X	X	Process	4.4	0.9	2
Patients with a provisional diagnosis of Stroke/CVA/TIA with a Stroke screening assessment performed (e.g.: FAST)	X	X	X	Process	4.7	0.6	2
Patients with a provisional diagnosis of Stroke/CVA/TIA with serial blood pressure measurements recorded (X3)	X	X	X	Process	4.1	1.1	3
Patients with a provisional diagnosis of Stroke/CVA/TIA delivered to a specialist Stroke Centre	X	X	X	Process	4.2	1.3	2
Patients with a provisional diagnosis of Stroke/CVA/TIA with direct delivery to CT scan	X	X	X	Process	4.0	1.2	2
Patients who received/met all components of the defined Stroke/CVA/TIA composite bundle score	X	X	X	Process	4.4	1.2	2
Trauma subcategory							
Patients designated as a trauma case with entrapment on scene documented	X	X	X	Process	3.6	0.9	3
Patients designated as a trauma case with a BP <90 mmHg		N/A		Process	4.0	1.4	2
Patients designated as a trauma case with partial/full amputation who had a tourniquet applied	X	X	X	Process	4.0	1.4	2
Patients designated as a trauma case with a femur fracture and traction splint use	X	X	X	Process	3.7	1.3	2
Patients designated as a trauma case with a BP <90 mmHg who were administered TXA			X	Process	4.4	1.0	2
Patients designated as a trauma case with direct transportation to a specialist Trauma Centre	X	X	X	Process	4.1	1.3	2

specific to the SA setting, this was not the primary objective of the study and remains an area for future research and expansion.

Discussion

Our study demonstrated that, through consensus, there are a broad set of QIs that are relevant and appropriate for use in the PEC setting in SA. Given the short amount of time that patients are exposed to these services, outcomes are difficult to measure, making the application of process-based QIs ideal for assessing quality and performance. This was evident in the output of our study, where process-based measures of care made up the majority of QIs reaching consensus agreement.

Table 4
Non-clinical category – QIs reaching consensus agreement.

Subcategory type	Applicable scope of practice			QI classification	Mean	SD	Round
	BLS	ILS	ALS				
Adverse Events subcategory							
Number of patient deaths while in EMS care	X	X	X	Sentinal Event	4.6	0.8	2
Number of defined Adverse Events reported during EMS care	X	X	X	Sentinal Event	4.6	1.0	2
Number of defined equipment/technical failures reported during EMS care		N/A		Sentinal Event	4.6	0.9	2
Number of accidental or unexpected extubations reported during EMS care			X	Sentinal Event	4.4	1.0	2
Number of patients with a decrease in GCS of 3 or more points during EMS care	X	X	X	Sentinal Event	3.9	1.1	3
Number of defined failed intubation attempts	X	X	X	Sentinal Event	4.3	1.1	2
Total number of patient injury reports during EMS care	X	X	X	Sentinal Event	4.3	0.9	2
Number of EMS staff on-duty injury reports		N/A		Sentinal Event	4.3	1.0	2
Number of defined medication errors during EMS care	X	X	X	Sentinal Event	4.6	0.6	2
Communications/Dispatch subcategory							
Number of cases compliant with defined ALS Dispatch criteria		N/A		Structure	4.0	1.1	2
Number of cases with call processing time within defined limits		N/A		Structure	4.1	1.1	2
Number of Service Call Centre calls received per 10000 population		N/A		Structure	4.2	1.0	2
Number of unanswered/missed calls to the Service Call Centre		N/A		Structure	4.4	1.0	2
Number of cases with a delay in dispatch and/or response time waiting for a police/security escort		N/A		Process	4.2	1.0	3

Historically, non-clinical/service-based measures have been the predominant focus for measuring and assessing PEC quality [6]. In contrast however, there was an overwhelming focus on clinical-based QIs reaching consensus in this study. Furthermore, the majority were focused on patient subsets for which PEC has been shown to have a positive impact, such as OHCA [29], ACS [30,31], airway management/breathing problems [32–34] and stroke [35].

This represents a significant shift away from time-based measures, which are often difficult to achieve in countries with geographically dispersed populations (i.e., proportionally high rural population) or those with an under-resourced response capability, such as that seen not only SA, but the broader LMIC setting. Similarly, the majority of the indicators reaching consensus were those that could be readily implemented without the need for complex data and information systems such as electronic patient care records or computer aided dispatch systems, compared to QIs previously described for more mature, "developed" PEC systems [36]. Furthermore, 58 (64%) of the clinical QIs and 12 of the non-clinical QIs (86%) are potentially applicable to non-ALS levels of care and therefore suitable for less mature systems or those with a narrower scope of practice than seen in SA.

Quality assessment promotes accountability to all stakeholders, including both service users and service providers. QIs represent a promising and important component within the assessment process by helping to identify and measure levels of service quality and performance. In and of themselves, QIs cannot improve quality. They effectively act as flags or alerts to identify good practice, provide comparability within and between similar services, identify opportunities for improvement, and provide direction where a more detailed investigation of standards is warranted. As such, their implementation and the manner in which their output is acted on are as equally important as their development. Similarly, applying QIs within any healthcare field requires a reasonable standard of documentation quality to be maintained. Maintaining such a standard through regular documentation quality audit and/or amendment to facilitate the use of QIs is a necessity to ensure their success.

PEC lends itself to assessment by QIs. This was evident in the number, variety and type of QIs reaching consensus agreement in our study. However, measuring quality in any healthcare setting is highly contextual. Within the South African setting, there are nonetheless a multitude of QIs that are relevant and appropriate for use in PEC. Furthermore, both the methodology employed and findings of this study may be used to inform the development of PEC specific QIs within other LMIC settings.

Dissemination of results

The results have not been formally shared.

Authors' contributions

Authors contributed as follows to the conception or design of the work; the acquisition, analysis, or interpretation of data for the work; and drafting the work or revising it critically for important intellectual content: IH contributed 50%, VL contributed 25%, PC contributed 15%, and LW and MC each contributed 5%. All authors approved the version to be published and agreed to be accountable for all aspects of the work.

Declaration of Competing Interest

Prof Lee Wallis is an editor of the African Journal of Emergency Medicine. Prof Wallis was not involved in the editorial workflow for this manuscript. The African Journal of Emergency Medicine applies a double blinded process for all manuscript peer reviews. The authors declared no further conflict of interest.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.afjem.2019.07.003.

References

1. Price L. Treating the clock and not the patient: ambulance response times and risk. Qual Saf Health Care 2006;15(2):127–30.
2. Pons PT, Markovchick VJ. Eight minutes or less: does the ambulance response time guideline impact trauma patient outcome? J Emerg Med 2002;23(1):43–8.
3. Heath G, Radcliffe J. Performance measurement and the english ambulance service. Public Money Manag 2007;27(3):223–8.
4. Maio RF, Garrison HG, Spaite DW, Desmond JS, M a Gregor, Cayten CG, et al. Emergency Medical Services Outcomes Project I (EMSOP I): prioritizing conditions for outcomes research. Ann Emerg Med 1999 Apr;33(4):423–32.
5. Spaite DW, Maio RF, Garrison HG, Desmond JS, Gregor MA, Stiell IG, et al. Emergency medical services outcomes project (EMSOP) II: developing the foundation and conceptual models for out-of-hospital outcomes. Ann Emerg Med 2001;37(6):657–63.
6. Howard I, Cameron P, Wallis L, Castren M, Lindstrom V. Quality indicators for evaluating prehospital emergency care: a scoping review. 2017;33(1):43–52.
7. Mainz J. Defining and classifying clinical indicators for quality improvement. Int J Qual Heal Care 2003 Dec;15(6):523–30.
8. Barber RM, Fullman N, Sorensen RJD, Bollyky T, McKee M, Nolte E, et al. Healthcare Access and Quality Index based on mortality from causes amenable to personal health care in 195 countries and territories, 1990–2015: a novel analysis from the Global Burden of Disease Study 2015. Lancet 2017;390(10091):231–66.
9. BD 2016 Healthcare Access and Quality Collaborators. Measuring performance on

the Healthcare Access and Quality Index for 195 countries and territories and selected subnational locations: a systematic analysis from the Global Burden of Disease Study 2016. Lancet. 2018;391:2236–71.
10. National Academies of Sciences; Engineering and Medicine. Crossing the global quality chasm: improving health care worldwide. Washington, DC: The National Academies Press; 2018.
11. Kruk ME, Gage AD, Arsenault C, Jordan K, Leslie HH, Roder-dewan S, et al. High-quality health systems in the Sustainable Development Goals era: time for a revolution. Lancet Glob Heal 2018;6(November):e1196–252.
12. Kobusingye O, Hyder A, Bishai D. Emergency medical services. 2nd ed Disease control priorities in developing countries New York: Oxford University Press; 2006. p. 1261–80.
13. Kobusingye OC, Hyder AA, Bishai D, Hicks ER, Mock C, Joshipura M. Emergency medical systems in low- and middle-income countries: recommendations for action. Bull World Health Organ 2005;83(8):626–31.
14. Pillay-van Wyk V, Msemburi W, Laubscher R, Dorrington RE, Groenewald P, Glass T, et al. Mortality trends and differentials in South Africa from 1997 to 2012: second National Burden of Disease Study. Lancet Glob Health 2016;4(9):e642–53.
15. Department of Health. A policy on quality in health care for South Africa. Dep Heal Repub South Africa; 2007.
16. Professional Board for Emergency Care. South African emergency medical services clinical practice guidelines. Pretoria. 2018.
17. Ambulance Victoria. Clinical practice guidelines - ambulance and MICA paramedics. 2016.
18. National Association of State EMS Officials. National Model EMS Guidelines. 2017.
19. Pre-Hospital Emergency Care Council. Clinical Practice Guidelines. 2014.
20. Boulkedid R, Abdoul H, Loustau M, Sibony O, Alberti C. Using and reporting the Delphi method for selecting healthcare quality indicators: a systematic review. PLoS One 2011;6(6):e20476.
21. Rubin HR, Pronovost P, Diette GB. From a process of care to a measure: the development and testing of a quality indicator. International J Qual Health Care 2001 Dec;13(6):489–96.
22. McGlynn EA, Asch SM. Developing a clinical performance measure. Am J Prev Med [Internet] 1998 Apr;14(3):14–21. Suppl.
23. Donabedian A. Evaluating the quality of medical care. Milbank Q 1966;44:166–206. Suppl.
24. Williams P, Webb C. The Delphi technique a methodological discussion. J Adv Nurs 1994;19:180–6.
25. Cole ZD, Donohoe HM, Stellefson ML. Internet-based Delphi research: case based discussion. Environ Manag 2013;51(3):511–23.
26. Powell C. The Delphi technique: myths and realities. J Adv Nurs 2003;41(4):376–82.
27. Bantel K. Comprehensiveness of strategic planning: the importance of heterogeneity of a top team. Psychol Rep 1993;73(1):35–49.
28. Walker A, Selfe J. The Delphi method: a useful tool for the allied health researcher. Br J Ther Rehabil 2014;3(12):677–81.
29. Link MS, Donnino MW, White RD, Paxton JH, Kudenchuk PJ, Halperin HR, et al. Part 7: adult advanced cardiovascular life support. Circulation. 2015;132(18 suppl 2):S444–64.
30. Gara PTO, Kushner FG, Ascheim DD, Casey DE. Guidelines et al on behalf of American C of CFHATF on P. ACCF/AHA guideline 2013 ACCF/AHA guideline for the management of ST-elevation myocardial infarction a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. Circulation. 2013(127):e362–425.
31. Ibanez B, James S, Agewell S, et al. on behalf of The Task Force for the management of acute myocardial infarction in patients presenting with ST-segment elevation of the European Society of Cardiology. 2017 ESC Guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation. Eur Heart J 2017;39(2):119–77.
32. British Thoracic Society Standards of Care Committee. British guideline on the management of asthma a national clinical guideline. Thorax. 2011;66(Suppl. 2):i1–23.
33. Japanese Society of Anesthesiologists. JSA airway management guideline 2014: to improve the safety of induction of anesthesia. J Anesth 2014;28(4):482–93.
34. Mebazaa A, Gheorghiade M, Piña IL, Harjola V-P, Hollenberg SM, Follath F, et al. Practical recommendations for prehospital and early in-hospital management of patients presenting with acute heart failure syndromes. Crit Care Med 2009;36:S129–39. Suppl.
35. Powers WJ, Rabinstein AA, Ackerson T, Adeoye OM, Bambakidis NC, Becker K, et al. 2018 Guidelines for the early management of patients with acute ischemic stroke: a guideline for healthcare professionals from the American Heart Association/American Stroke Association. Stroke 2018;49. (46-110 p.).
36. Murphy A, Wakai A, Walsh C, Cummins F, O'Sullivan R. Development of key performance indicators for prehospital emergency care. Emerg Med J 2016;33(4):286–92.

Multi-method vs single method appraisal of clinical quality indicators for the Emergency Medical Services

ABSTRACT

Background

Quality Indicator (QI) appraisal protocols are a novel methodology that combines multiple appraisal methods to comprehensively assess the "appropriateness" of QIs for a particular healthcare setting. However, they remain inadequately explored compared to the single appraisal method approach. This paper aimed to describe and test a QI appraisal protocol versus the single method approach, against a series of QIs potentially relevant to the South African Prehospital Emergency Care setting.

Methods

An appraisal protocol was developed consisting of two categorical-based appraisal methods, combined with the qualitative analysis of the discussion generated during the consensus application of each method. The output of the protocol was assessed and compared with the application and output of each method. Inter-rater reliability of each particular method was evaluated prior to group consensus rating. Variation in the number of non-valid QIs and the proportion of non-valid QIs identified between each method and the protocol were compared and assessed.

Results

There was mixed IRR of the individual methods. There was similarly low to moderate correlation of the results obtained between the particular methods (Spearman's rank correlation=0.42,$p<0.001$). From a series of 104 QIs, 11 non-valid QIs were identified that were shared between the individual methods. A further 19 non-valid QIs were identified and not shared by each method, highlighting the benefits of a multi-method approach. The outcomes were additionally evident in the group discussion analysis, which in and of itself added further input that would not have otherwise been captured by the individual methods alone.

Conclusion

The utilization of a multi-method appraisal protocol offers multiple benefits, when compared to the single appraisal approach, and can provide the confidence that the outcomes of the appraisal will ensure a strong foundation on which the QI framework can be successfully implemented.

Multi-method vs single method appraisal of clinical quality indicators for the Emergency Medical Services

BACKGROUND

The Institute of Medicine defines healthcare quality as "*the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge*''[1]. Objectively assessing the extent to which this is achieved can be a challenging task, given that quality is a relatively abstract concept. It stands to reason, therefore that a central tenet to defining quality is the system used towards its measurement.

The measurement of healthcare quality provides an essential mechanism towards directing policy; benchmarking performance; guiding improvement initiatives and maintaining accountability of the system[2–4]. Consequently, multiple users will consume quality data in a variety of ways to achieve these aims. Therefore, for any measurement system to be successful, it is fundamental that it be comprehensive in its approach, yet simple in its design, and contextually relevant to provide an appropriate measure of quality.

Considerable progress has been made towards improving Prehospital Emergency Care (PEC) quality measurement, mainly through the development of PEC-specific quality indicators (QIs)[5–7]. In and of themselves, QIs cannot improve quality; they effectively provide clinicians and organizations with a quantitative basis to monitor, evaluate, and improve the quality of patient care, clinical support services, and organizational function[3,4]. Despite their advantages, the objective appraisal of quality measurement systems is often neglected, leading to the potential for implementation of inappropriate QIs. In the PEC environment, this is already evident in the literature where less than 15% of QIs have undergone some form of measure evaluation[7]. The consequences of inadequately assessed reliability, validity and bias in quality measurement can in the best-case scenario prove to be time-consuming and costly, and in the worst-case scenario potentially undermine the system in its entirety[8,9].

Several methodologies to appraise QIs have been described and utilized with considerable success[9–17]. While there is a level of overlap or commonality in the components they assess, the process towards their application can vary significantly[9–17]. Therefore, the potential exists for variation in the outcomes of these methodologies when applied to a common data set. QI appraisal protocols are a novel methodology that combines multiple appraisal methods to comprehensively assess the "appropriateness" of QIs for a particular setting[9]. There is limited evidence to suggest benefits with the use of such protocols; however, they remain inadequately explored compared to the single appraisal method approach. This paper aimed to therefore describe and test a multi-method QI appraisal protocol versus the single method

approach, against a series of QIs previously identified as potentially relevant to the PEC setting.

METHODS

The triangulation and integration of multiple data types have been increasingly recognized as a valuable approach to the study of healthcare delivery[18–20]. For this study, an appraisal protocol was developed consisting of two categorical-based appraisal methods, the Qualify appraisal tool and RAND Appropriateness method, combined with the qualitative analysis of the consensus application of each process, by a QI Appraisal Working Group. The protocol was tested against a series of QIs recently identified for potential relevance and used in the South African EMS setting and applied over three rounds (Figure 1). The final results of the protocol were compared and assessed against the outcomes of each method, with the rounds 1 and 3 serving as their own control test against the protocol (Table 3 provides the full list of QIs used for evaluation. See supplementary file for the data dictionary for each QIs).

For round 1, the Qualify QI appraisal tool was selected given its focus on feasibility[11,12], and consists of four-level Likert scale questions (1=Does not apply; 2=Rather does not apply; 3=Rather applies; 4=Applies) to assess 18 criteria amongst three categories: *Relevance*; *Scientific Soundness* and *Feasibility* (Table 1). For round 3, the Rand Appropriateness Method was included due to its practical focus (i.e., the data extraction)[14–17] to further rate the indicators by testing the definitions, data components and criteria for use developed for each QI against several clinical vignettes. Four categories (*Clarity*, *Necessity*, *Acceptability* and *Technical Feasibility*) were rated using a 9-point visual analogue scale, and data extraction assessed using a mock-up of a generic patient report form for the vignettes[9,13]. Two separate vignettes were developed for each of the QI categories included in the data extraction, and a "low-quality documentation" and "high-quality documentation" version developed for each vignette used during the assessment.

Both methods consisted of an evidence evaluation component as part of the appraisal process. To achieve this, the QIs were assessed for inclusion within local clinical practice guidelines (CPGs), and against the results of a literature review of the evidence base utilized for the development of PEC focused QIs. For the review, articles were identified by searching the following databases: PubMed; Embase; Cumulative Index to Nursing and Allied Health Literature (CINAHL); Web of Science; and the Cochrane Library. All searches were performed with no restrictions in terms of publication type or journal subset, date of publication, or patient age. Where applicable, searches were limited to English language articles and research involving human subjects only. Combinations and truncated variations of the following search terms were used for each database search: *Emergency Medical Service, prehospital emergency care, ambulance service, quality indicator, quality measure, performance measure, and performance indicator*. Appropriate wildcards were used to

account for singular and plural forms of each of the search terms. Variations in spelling were additionally used in varying combinations to broaden the search.

Inclusion Criteria

For this study, a QI was defined as *any measure that compared actual care against ideal criteria; or a tool used to help assess quality and/or performance*. The following minimum criteria were utilized when identifying studies for further analysis:

- Research that focused on the development and/or implementation of prehospital focused QIs
- The primary aim of the research was to describe, analyse, discuss or provide evidence for prehospital focused QIs

Exclusion Criteria

Non-English research, studies that examined disaster management/ major incident response QIs, or research aimed at inter-facility transport measures of care were excluded. Furthermore, secondary research that examined QIs developed as part of a primary study already included in the analysis was excluded.

Article Review

Eligible articles were identified and analysed independently in three parts by the primary author (IH) and two participants of the working group. Full-text articles remaining after a title and abstract review were independently reviewed for the satisfaction of the inclusion and exclusion criteria, and to determine whether they provided evidence for at least one indicator. The level of evidence for each article and QI was assessed and presented using the Oxford Centre for Evidence-based Medicine Levels of Evidence[21].

Data for parts 1 and 2 were collected over three rounds of group discussion of a QI Appraisal Working Group. An initial introductory round was conducted to familiarize the Working Group with the QUALIFY tool, Rand methodology, results of the literature review, and provide the data dictionary for the QI set. The data dictionary was the primary documented utilized by the Working Group for the application of each appraisal method and outlined 19 definable components for each QI. (Figure 2)

Prior to Round 1, the QUALIFY tool was independently applied by each member of the Working Group, who then met to discuss their individual scoring and apply a final consensus summary score during Round 1. Prior to Round 2, the Working Group similarly independently assessed the results of the literature review and then met to apply a final consensus rating of the evidence during Round 2. For round 3, the Working Group met to compare their individual data extraction results and rate the QIs using the Rand method. The Working Group meetings were recorded and later transcribed for the final part of data collection – content

analysis of the discussion generated surrounding the consensus appraisal process for Rounds 1 to 3.

Setting and Population

Traditionally, quality in the PEC setting has been exclusively reported based around response time targets[22–25]. This is no different from what is found in South Africa, where the utilization and reporting of clinically focused QIs by the Emergency Medical Services (EMS) are wholly lacking. Towards this, several clinically focused QIs have recently been identified for potential relevance to the SA PEC setting[26]. These QIs were used to test the appraisal protocol, with the secondary aim of identifying those QIs appropriate for use in the SA PEC setting.

The QI Appraisal Working Group consisted of nine experts chosen for their intricate knowledge of the South African PEC setting and to align with minimum panel size recommendations for each methodology[10,13]. All the participants were South African trained and post-graduate educated Emergency Care Practitioners (ECPs) with > 10 years of operational experience each. Six of the participants' primary experience and occupation were in quality governance and improvement within PEC, and the remaining three were primarily involved in clinical operations. The Working Group were given one month between each round with which to work through the information and data collection required for each subsequent round.

Data Analysis

Descriptive statistics were utilized to describe and summarize categorical based appraisal data. For the QUALIFY tool, mean scores per category, and the number of criteria scoring 3 (Rather applies) or 4 (Applies) were calculated for each QI. For the Rand method, consensus scores per category, and the proportion of categories scoring ≥7 were calculated. Inter-rater reliability (IRR) for each criterion of both the QUALIFY tool and Rand method were calculated using percentage agreement and Gwet's AC1.

A final composite score was calculated for each QI, for each method. For the QUALIFY tool, this was calculated using a weighted mean of the appraisal categories after consensus, due to the differences in the number of criteria per class. To be considered a valid indicator, the QI had to score ≥3 based on the final composite score. For the Rand method, the unweighted mean of the appraisal categories after consensus was used. To be considered a valid indicator, the QI had to score ≥7 based on the final composite score. A second group of QIs were identified consisting of those scoring on the validity threshold (3.0-3.1 for the Qualify tool; 7.0-7.1 for the Rand method) for which caution was recommended before full implementation.

Correlation between the final composite scores was calculated using the Spearman's rank correlation. The consensus derived proportion of non-valid QIs, and QIs for which caution

was recommended, identified by each individual method and the protocol, were calculated and assessed against each other using the z-test. 95% confidence intervals were calculated where necessary and a p-value of 0.05 used as a cut-off for the strength of evidence. All data were entered and analysed using a combination of Microsoft Excel 2010 (Microsoft Corp., Richmond, WA, USA) and Stata version 16 (StataCorp. College Station, TX: StataCorp LLC).

Conventional content analysis, as described by Hsieh and Shannon, was utilized to sort and analyse the group discussions generated during the three rounds[27]. Recordings and transcripts were created for each round, and each transcript reread for content familiarisation. First-level coding was conducted through the extraction of meaning units from each transcript and summarised into codes using open-coding from each interview. Once completed, similar codes were combined and organized to develop clustered subcategories pertaining to each appraisal tool. Transcriptions were analysed using MAXQDA software for data storage; extraction of meaning units and subcategory development (MAXQDA, 2016; Sozialforschung GmbH, Berlin, Germany).

RESULTS

The Working Group appraised a total of 90 *clinical* and 14 *non-clinical* (n=104) QIs using each method, over the three rounds. There was a high level of validity of the QIs assessed across the majority of the appraisal criteria for both methods, the results of which were moderately correlated between each method.

Round 1 - QI Appraisal Tool

There was mixed IRR of the criteria found prior to the group consensus. *Validity* and *Understandability & interpretability for medical personnel* scored perfect agreement by the Working group. In contrast, *Data Collection Effort* (% agreement=22%, IRR=0.01) and *Understandability & interpretability for patients and interested public* (% agreement=28%, IRR=0.09) and scored the lowest (Table 2). Of the 104 QIs assessed, eight (7.7%) scored less than the validity threshold on the final composite score (≥3). All eight scored relatively high for *Relevance* and *Scientific Soundness* yet scored poorly for *Feasibility*. A further 15 QIs scored on the validity threshold (3.0-3.1).

To appraise the *Indicator Evidence* criterion within the *Scientific Soundness* category, the QIs were evaluated for inclusion within local CPGs. There was considerable representation of the QIs amongst the SA national EMS CPGs (Table 3). Seventy-nine QIs (76%) were accounted for in the CPGs, of which 76 (73%) had evidence directly supporting their use. Those QIs not represented were found to be either structure-based QIs; clinical bundle-based QIs; or those QIs focusing on sentinel events and patient safety.

Round 2 – Literature Review

The literature search identified a total of 1624 potential articles for review (Figure 3). Following a title and abstract review, 1528 articles did not meet inclusion criteria and were excluded, leaving 89 articles for full-text review. Following the removal of duplicate texts, and research not meeting the inclusion criteria (n=57) 31 articles remained for the full-text review. The literature review found an evidence base for 11 of the 15 Clinical subcategories and the 2 Non-clinical subcategories, plus an additional 4 subcategories not included in the QI appraisal, covering 311 indicators (Table 4). More than half (59%) were developed through a consensus/expert opinion-based approach, with fewer developed via more robust and higher quality levels of evidence such as systematic reviews or cohort and case control-based studies (10% each).

Round 3 – Rand Method

As with the appraisal tool, there was mixed IRR in the individual rating prior to the consensus rating, with *Acceptability* scoring the highest (% agreement=90%, IRR=0.9) and *Technical Feasibility* the lowest (% agreement=47%, IRR=0.32). Eleven QIs (10.6%) scored below the validity threshold, and a further eight QIs scored on the validity threshold (7.0-7.1). In total, from a series of 104 QIs, eight were identified as non-valid and three identified for which caution was recommended before full implementation, that were shared between the appraisal methods. A further 19 QIs were identified as non-valid and not shared by each method.

Comparison of Categorical Appraisal Methods

When final consensus validity scores were compared, there was poor to moderate correlation of the results between the QUALIFY tool and Rand method (Spearman's rank correlation=0.42, p<0.001). Ninety-two of the 104 QIs (88%) (78 *clinical* and 14 *non-clinical*) were appraised to be valid and feasible for the SA PEC setting, based on the results of this study. Of this group, an additional 21 QIs (13 *clinical* and eight *non-clinical*) were assessed to be on the threshold of validity, in which caution is recommended before full implementation. There was little evidence to support a statistical difference in the proportion of non-valid QIs identified between the Qualify tool and the Rand method [difference=-0.03; (95%CI -0.12:0.05,p=0.47)]; between the Qualify tool and the protocol [difference=-0.05; (95%CI -0.13:0.03,p=0.25)]; or between the Rand method and the protocol [difference=-0.02; (95%CI -0.11:0.07,p=0.66)]. There was likewise little evidence to support a statistical difference in the proportion of QIs in which caution is recommended, identified between the Qualify tool and the Rand method [difference=0.07; (95%CI -0.02:0.15,p=0.12)]; or between the Qualify tool and the protocol [difference=-0.06; (95%CI -0.16:0.04,p=0.27)]. There was, however, strong evidence to support a statistical difference between the proportion of QIs in which caution is recommended, identified between the Rand method and the protocol [difference= -0.13; (95% CI -0.22:-0.03,p=0.009)].

Discussion Group Content Analysis

Several observations highlighted during the group discussions were found to be important considerations regarding the appraisal protocol and its ability to assess the appropriateness of the QIs. For the QUALIFY tool, *Relevance* and *Scientific Soundness* were perceived to be characteristics inherent to the QIs (and supporting data components) themselves, and as a result, were generally appraised to be highly applicable across all QIs and criteria (Table 5). In contrast, *Feasibility* was judged to be more of a gauge of the system in which the QIs would be implemented and as such, scores were found to be on average lower amongst these criteria [1.1, 1.2]. Somewhat related to this was the broader issue of context and the importance of selecting those indicators that best suited the local setting, before full implementation (1.3, 1.4]. Despite the focus on the appraisal of the QIs, on several occasions, the discussion steered towards the need for EMS organizations in SA to improve their quality systems in general if such measures are to be implemented [1.5, 1.6].

For the Rand method, the importance of having completed the practical data extraction using the case vignettes made a difference in the QI rating [2.1,2.2]. This expanded further into a general conversation about applying the QI framework, the quality system in which they'd be used and documentation in general [2.3 – 2.6].

DISCUSSION

The simplicity and practicality of QIs as a system of quality measurement has led to their widespread adoption in healthcare[4,14,28–34]. They align with Donabedian's conceptual framework for healthcare evaluation, predicated on the belief that an effective structure gives rise to effective processes of care, which in turn result in improved outcomes[8]. Importantly, there is no evidence to suggest that QIs have the potential to reduce mortality and morbidity if implemented and utilized effectively[35,36]. Within the PEC setting, patient exposure times are generally limited, and the delivery of care mainly based around processes as opposed to outcomes. The utilization of QIs as a measure of quality are, therefore ideally suited to this environment.

Despite these advantages, the implementation of inappropriate or poorly tested QIs - even in well-established quality systems - has been reported to be both time-consuming and costly to correct[9,14]. Furthermore, the clinical implications are potentially varied and far-reaching. Inappropriate QIs implemented within a particular setting will potentially lead to improper changes to clinical care that could unnecessarily and negatively impact patient safety. Moreover, inappropriately implemented QIs could additionally avert focus from unmonitored issues more suitable for the setting in question, thus too impacting patient safety. Consequently, QI appraisal has been identified as an essential step toward understanding the appropriateness of these measures for a particular healthcare field or setting, before full implementation. The results of this study support these notions through the application of QI appraisal protocol against a series of QIs. Further to this, the results support the value in

adopting a multi-method approach towards QI appraisal, compared to the single method approach.

Our observations found the multi-method approach to be advantageous in that the methods complemented each other's strengths and compensated for each other's weaknesses. While the Qualify tool appraised the QIs from a greater number of viewpoints, the Rand approach offered insight into the practical application of the QIs not available with the Qualify tool. This was additionally evident in the group discussion analysis, which in and of itself added further input towards understanding and appraising the appropriateness of the QIs that would not have otherwise been captured or understood by the categorical methods alone[18,37].

Despite these advantages, the application of the protocol required a significant investment in time and staff resources. The overall benefits of such an approach are therefore heavily dependent on the availability of these resources. This availability will likely vary significantly, depending on the quality system setting within which the protocol will be applied. These "system-focused" factors, therefore, have the potential to exert as much influence on the validity of the QIs as the setting in which the QIs will be implemented[38,39].

The outcomes of the appraisal have identified a significant number of QIs assessed to be valid and feasible for the SA PEC setting. The majority are centred around clinically focused processes of care, measures that are lacking in current performance assessment in EMS in SA. The importance and potential influence of the quality system in which the QIs will be implemented was further highlighted across all the methodologies. Quality system-focused assessment criteria, on average, scored lower than those criteria assessed to be characteristics inherent to the QIs themselves. This was reaffirmed during the qualitative discussion analysis, where system focused factors were a common discussion point.

Limitations

While the specific results of this study may not be readily generalizable to other settings or services, the concept of employing appraisal protocols to identify maximally relevant and appropriate QIs for use in a particular setting is well demonstrated in this paper. However, their outcomes are dependent on several factors that would need to be considered. Firstly, the inclusion of other appraisal tools in an appraisal protocol will likely produce different results to those observed in this study. The tools included in our protocol were chosen given their primary focus; however, other services or settings may place greater emphasis on qualities found in other appraisal tools. Secondly, the composition of the working group applying the tools and protocols could potentially use the same tools in a different manner. The make-up of the group should be focused on the setting and service type and where possible, include individuals with experience and training in quality assessment and improvement or patient safety. Lastly, results will likely vary depending on the QIs under study, their purpose and focus.

CONCLUSION

Measurement forms a central part of every healthcare quality system. Regardless of the approach used, the framework must be comprehensively assessed for appropriateness for the setting in which it will be employed. Understanding and accounting for this as a factor is vital towards ensuring both successful implementation and ongoing utilization of quality systems in any setting. The utilization of a multi-method appraisal protocol offers significant benefit towards achieving this, when compared to the single appraisal approach, and can provide the confidence that the outcomes of the appraisal will ensure a strong foundation on which the measurement framework can be successfully implemented and employed.

ABBREVIATIONS

PEC: Prehospital Emergency Care
QI: Quality Indicator
SA: South Africa
CPG: Clinical Practice Guideline
IHI: Institute for Healthcare Improvement
EMS: Emergency Medical Services
ECP: Emergency Care Practitioner
ACS: Acute Coronary Syndrome
CI: Confidence Interval
CINAHL: Cumulative Index to Nursing and Allied Health Literature

FIGURES

Figure 1: Quality Indicator appraisal protocol
Figure 2: Data Dictionary components
Figure 3: Selection of articles for review

DECLARATIONS

Ethics approval and consent to participate

Ethical approval for the study was granted by the Stellenbosch University Health Research Ethics Committee (HREC) (Ref no. S15/09/193). Written consent for participation was provided by each of the participants before data collection. The datasets used and analysed during the current study available from the corresponding author on reasonable request.

Consent for publication

Not applicable/required

Competing interests

The authors declare that they have no competing interests.

Funding

Nil

Authors' contributions

IH, PC, MC, LW and VL conceived the study. IH, conducted the data collection and analysis. IH drafted the manuscript, and all authors contributed to its revision. All authors have read and approve of the final manuscript, and consent to its publication. IH takes responsibility for the paper.

Acknowledgements

Nil

REFERENCES

General

1. National Academies of Sciences; Engineering and Medicine. Crossing the global quality chasm: Improving health care worldwide. Washington, DC: The National Academies Press; 2018.
2. Mant J. Process versus outcome indicators in the assessment of quality of health care. Int J Qual Heal Care 2001;13(6):475–80.
3. Mainz J. Defining and classifying clinical indicators for quality improvement. Int J Qual Heal care 2003;15(6):523–30.
4. Mainz JAN. Developing evidence-based clinical indicators : a state of the art. Int Jounral Qual Healthc 2003;15(Suppliment 1):5–12.
5. Maio RF, Garrison HG, Spaire DW, et al. Emergency medical services outcomes project I (EMSOP I): Prioritizing conditions for outcomes research. Ann Emerg Med 1999;33(4):423–32.
6. Spaite DW, Maio RF, Garrison HG, et al. Emergency Medical Services Outcomes Project (EMSOP) II : Developing the Foundation and Conceptual Models for Out-of-Hospital Outcomes. Ann Emerg Med 2001;37(6):657–63.
7. Howard I, Cameron P, Wallis L, Castren M, Lindstrom V. Quality Indicators for Evaluating Prehospital Emergency Care: A Scoping Review. 2017;
8. Donabedian A. Evaluating the Quality of Medical Care. Milbank Q 1966;44(Suppl):166–206.
9. Campbell S, Kontopantelis E, Hannon K, Burke M, Barber A, Lester H. Framework and indicator testing protocol for developing and piloting quality indicators for the UK quality and outcomes framework. BMC Fam Pract. 2011;12:85.
10. BQS - Institute of Quality and Patient Safety. QUALIFY: Instrument for the Assessment of Quality Indicators. 2007;(August):60.
11. De Cruppé W, Kleudgen S, Diel F, Burgdorf F, Geraedts M. Feasibility of 48 quality

indicators in ambulatory care in Germany: A cross-sectional observational study. Z Evid Fortbild Qual Gesundhwes. 2015;109(9–10):682–94.
12. Bieler D, Hörster A, Lefering R, et al. Evaluation of new quality indicators for the TraumaRegister DGU using the systematic QUALIFY methodology. Eur J Trauma Emerg Surg [Internet] 2018;0(0):0.
13. Fitch K, Bernstein SJ, Aguilar MD, et al. The RAND/UCLA Appropriateness Method User's Manual. 2001;
14. Marshall M, Campbell S, Kirk SM, Brook RD, McGlynn E, Shekelle PG. Measuring General Practice: A demonstration project to develop and test a set of primary care clinical quality indicators Professors of General Practice. 2003;
15. Santori G, Fontana I, Valente R, Ghirelli R, Valente U. Application of the RAND/UCLA Appropriateness Method to Evaluate an Information System for Kidney/Pancreas Transplantation in Adult Recipients. Transplant Proc 2008;40(6):2021–3.
16. Bobrovitz N, Parrilla JS, Santana M, Straus SE, Stelfox HT. A qualitative analysis of a consensus process to develop quality indicators of injury care. Implement Sci. 2013;8:45.
17. Grudzen CR, Liddicoat R, Hoffman JR, Koenig W, Lorenz KA, Asch SM. Developing quality indicators for the appropriateness of resuscitation in prehospital atraumatic cardiac arrest. Prehospital Emerg care. 2007;11(4):434–42.
18. Curry LA, Nembhard IM, Bradley EH. Qualitative and mixed methods provide unique contributions to outcomes research. Circulation 2009;119(10):1442–52.
19. O'Cathain A, Murphy E, Nicholl J. Three techniques for integrating data in mixed methods studies. BMJ 2010;341(7783):1147–50.
20. Johnson RB, Onwuegbuzie AJ. Mixed Methods Research: A Research Paradigm Whose Time Has Come. 1973;
21. Howick J, Phillips B, Ball C, Sackett D, Badenoch D. Oxford Centre for Evidence-based Medicine Levels of Evidence. 2009;Available from: https://www.cebm.net/2009/06/oxford-centre-evidence-based-medicine-levels-evidence-march-2009/
22. Department of Health KZN. 2017 / 18 Annual Report. Annu. Rep. 2016/17. 2018;1–417.
23. North West Department of Health. Annual Report. 2018;
24. Western Cape Department of Health. Western Cape Government,Department of Health Annual Report. 2017;
25. Limpopo Department of Health. Annual Report. Annu. Rep. 2017/18 Financ. Year. 2018;
26. Howard I, Cameron P, Wallis L, Castrén M, Lindström V. Identifying quality indicators for prehospital emergency care services in the low to middle income setting: The South African perspective. African J Emerg Med. 2019; 9(4): 185 - 192
27. Hseih H-F, Shannon SE. Three Approaches to Qualitative Content Analysis. Qual Health Res 2005;15(9):1277–88.
28. Kollberg B, Elg M, Lindmark J. Design and implementation of a performance measurement system in Swedish health care services: a multiple case study of 6 development teams. Qual. 2005;14(2):95–111.
29. Coleman P, Nicholl J. Consensus methods to identify a set of potential performance indicators for systems of emergency and urgent care. J Health Serv Res Policy. 2010 [cited 2014 Sep 30];15 Suppl 2:12–8.
30. Hoogervorst EM, van Beeck EF, Goslings JC, Bezemer PD, Bierens JJLM. Developing

process guidelines for trauma care in the Netherlands for severely injured patients: results from a Delphi study. BMC Health Serv Res. 2013;13(1):79.
31. Abrams H, Belanger F, Carew D, et al. Prioritizing performance measurement for emergency department care : consensus on evidence- based quality of care indicators Steering committee. 2011;13(5):28–43.
32. Nakayama DK, Saitz EW, Gardner MJ, Kompare E, Guzik E, Rowe MI. Quality assessment in the pediatric trauma care system. J Pediatr Surg. 1989;24(2):159–62.
33. Mackenbach JP, McKee M. A comparative analysis of health policy performance in 43 European countries. Eur J Public Health. 2013. ;23(2):195–201.
34. Groene O, Klazinga N, Kazandjian V, Lombrail P, Bartels P. The World Health Organization Performance Assessment Tool for quality improvement in hospitals (PATH): An analysis of the pilot implementation in 37 hospitals. Int J Qual Heal Care 2008;20(3):155–61.
35. Jarvis JL, Gonzales J, Johns D, Sager L. Implementation of a Clinical Bundle to Reduce Out-of-Hospital Peri-intubation Hypoxia. Ann Emerg Med. 2018;72(3):272-279
36. Dusheiko M, Gravelle H, Martin S, Smith PC. Quality of disease management and risk of mortality in english primary care practices. Health Serv Res 2015;50(5):1452–71.
37. Van Harten WH, Casparie TF, Fisscher OAM. Methodological considerations on the assessment of the implementation of quality management systems. Health Policy (New York) 2000;54(3):187–200.
38. Kaplan HC, Provost LP, Froehle CM, Margolis PA. The model for understanding success in quality (MUSIQ): Building a theory of context in healthcare quality improvement. BMJ Qual Saf 2012;21(1):13–20.
39. Vaughn VM, Saint S, Krein SL, et al. Characteristics of healthcare organizations struggling to improve quality: Results from a systematic review of qualitative studies. BMJ Qual Saf 2019;28(1):74–84.

Quality Indicator Evidence Base Review

1. Norris RM. A new performance indicator for acute myocardial infarction. Heart. 2001;85(4):395–401.
2. Sobo E, Andriese S, Stroup C, Morgan D, Kurtin P. Developing Indicators for EMS Evaluation and Quality Improvement. Jt Comm J Qual Improv. 1992;27(3):138–54.
3. Siriwardena a N, Shaw D, Donohoe R, Black S, Stephenson J. Development and pilot of clinical performance indicators for English ambulance services. Emerg Med J. 2010;27(4):327–31.
4. Siriwardena AN, Shaw D, Essam N, et al. The effect of a national quality improvement collaborative on prehospital care for acute myocardial infarction and stroke in England. Implement Sci. 2014;9:17.
5. Myers JB, Slovis CM, Eckstein M, et al. Evidence-based performance measures for Emergency Medical Service systems – A Model for expanded EMS benchmarking. Prehospital Emerg Care 2008;12:141–51.
6. Colwell C, Mehler P, Harper J, Cassell L, Vazquez J, Sabel A. Measuring quality in the prehospital care of chest pain patients. Prehospital Emerg Care. 2009;13:237–40.

7. Rosengart MR, Nathens AB, Schiff M a. The identification of criteria to evaluate prehospital trauma care using the Delphi technique. J Trauma 2007;62(March):708–13.
8. Mohan D, Rosengart MR, Farris C, Fischhoff B, Angus DC, Barnato AE. Sources of non-compliance with clinical practice guidelines in trauma triage: a decision science study. Implement Sci. 2012;7:103.
9. HT S, Bobranska-Artiuch B, Nathens A, SE S. A systematic review of quality indicators for evaluating pediatric trauma care. Crit Care Med. 2010;38(4):1187-1196 10p.
10. Stelfox HT, Bobranska-Artiuch B, Nathens A, Straus SE. A systematic review of quality indicators for evaluating pediatric trauma care. Crit Care Med. 2010;38(4):1187–96.
11. Myers JB, Slovis CM, Eckstein M, et al. Evidence-Based Performance Measures for Emergency Medical Services Systems: A Model for Expanded EMS Benchmarking. Prehospital Emerg Care.2008;12(2):141–51.
12. Santana MJ, Stelfox HT. Development and evaluation of evidence-informed quality indicators for adult injury care. Ann Surg. 2014;259(1):186–92.
13. Dunford J, Domeier RM, Blackwell T, et al. Performance Measurements in Emergency Medical Services. Prehospital Emerg Care. 2002;6(1):107–13.
14. Nakayama DK, Saitz EW, Gardner MJ, Kompare E, Guzik E, Rowe MI. Quality assessment in the pediatric trauma care system. J Pediatr Surg. 1989;24(2):159–62.
15. Patterson PD, Lave JR, Martin-Gill C, et al. Measuring Adverse Events in Helicopter Emergency Medical Services: Establishing Content Validity. Prehospital Emerg Care. 2014;18(1):35–45. A
16. Hoogervorst EM, van Beeck EF, Goslings JC, Bezemer PD, Bierens JJLM. Developing process guidelines for trauma care in the Netherlands for severely injured patients: results from a Delphi study. BMC Health Serv Res. 2013;13(1):79.
17. Greenberg MD, Garrison HG, Delbridge TR, et al. Indicators for out-of-hospital Emergency Medical Services: The Paramedics Perspective. Prehospital Emerg Care. 1997;1:23–7.
18. Meara PO. A generic performance framework for ambulance services : an Australian health services perspective. 2012;3(3).
19. Stelfox HT, Straus SE, Nathens A, Bobranska-Artiuch B. Evidence for quality indicators to evaluate adult trauma care: a systematic review. Crit Care Med. 2011;39(4):846–59.
20. Valenzuela TD, Spaite DW, Meislin HW, Clark LL, Wright AL, Ewy GA. Emergency vehicle intervals versus collapse-to-CPR and collapse-to-defibrillation intervals: Monitoring emergency medical services system performance in sudden cardiac arrest. Ann Emerg Med. 1993;22(11):1678–83.
21. Grudzen CR, Liddicoat R, Hoffman JR, Koenig W, Lorenz KA, Asch SM. Developing quality indicators for the appropriateness of resuscitation in prehospital atraumatic cardiac arrest. Prehospital Emerg care. 2007;11(4):434–42.
22. Patterson PD, Lave JR, Martin-Gill C, et al. Measuring Adverse Events in Helicopter Emergency Medical Services: Establishing Content Validity. Prehosp Emerg Care. 2013

23. Daudelin DH, Kulick ER, Amore KD, Lutz JS, Barrientos MT, Foell K. The Massachusetts Emergency Medical Service Stroke Quality Improvement Collaborative 2009 - 2012. Prev Chronic Dis. 2013;10.
24. Siriwardena AN, Shaw D, Essam N, et al. The effect of a national quality improvement collaborative on prehospital care for acute myocardial infarction and stroke in England. Implement Sci. 2014;9(17):1–9.
25. Oostema JA, Nasiri M, Chassee T, Reeves MJ. The quality of prehospital ischemic stroke care: Compliance with guidelines and impact on in-hospital stroke response. J Stroke Cerebrovasc Dis. 2014;23(10):2773–9. 0
26. Stelfox HT, Straus SE. Measuring quality of care: Considering measurement frameworks and needs assessment to guide quality indicator development. J Clin Epidemiol. 2013;66(12):1320–7.
27. Nakayama DK, Gardner MJ, Waggoner T. Audit Filters in Quality Assurance in Pediatric Trauma Care. J Pediatr Surg. 1993;28(1):19–25.
28. Patterson PD, Probst JC, Moore CG. Expected annual emergency miles per ambulance: an indicator for measuring availability of Emergency Medical Services resources. J Rural Health. 2006;22(2):102–11.
29. Greenberg MD, Garrison HG, Delbridge TR, et al. Quality indicators for out-of-hospital emergency medical services: the paramedics' perspective. Prehosp Emerg Care. 1997;1(1):23–7.
30. Gitelman V, Auerbach K, Doveh E. Development of road safety performance indicators for trauma management in Europe. Accid Anal Prev. 2013;60:412–23.
31. Willis CD, Gabbe BJ, Cameron PA. Measuring quality in trauma care. Injury 2007;38(5):527–37.

Figure 1

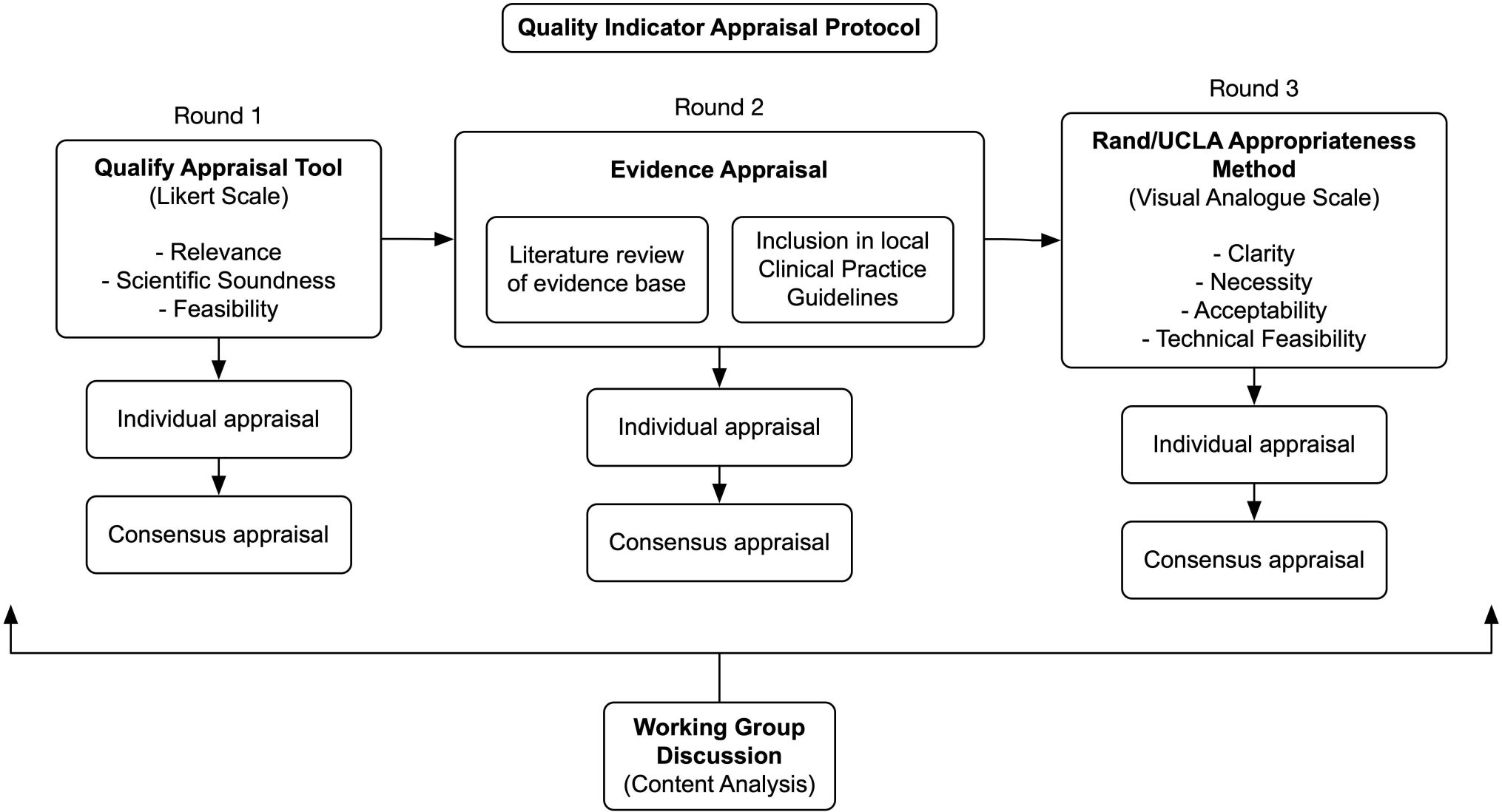


Figure 2

Abbreviated Name	Abbreviated QI name
Definition	Basic description/purpose of the QI
Domain	Primary area of focus of the QI
Subdomain	Secondary area, within the Domain that is the subarea of focus
Clinical Pathway/Service Pathway	Identifies the Domain and Subdomain within which the QI is positioned
Measure Type	Structure, process or outcome focus
Target Population	Domain level population on whom the QI is measured/applied
Unit of Analysis	EMS component under study/assessment for quality and performance
Numerator Statement	Description of the subset of the subdomain population on whom the quality indicator is measured/applied
Denominator Statement	Description of the subdomain level of population on whom the quality indicator is measured/applied
Case Mix/Risk Adjustment	Suggested differentiation amongst the denominator population for greater accuracy (i.e.: stratification)
Exclusion Criteria	Denominator cases to be excluded when applying the QI
Measure Calculation	The equation for calculating the QI
Numerical Reporting Format	Suggested format in which the numerical results should be reported
Graphical Reporting Format	Suggested format in which the results should be displayed/visualized
Reported Indicator	Suggested output in which results should be described
Data Source	Suggested data source to obtain the data required for calculating the QI
Suggested Reporting Period	Timeframe, number of successive cases or other grouping strategies cases should be aggregated for reporting purposes
Recommended Review Period	Suggested time period at which the QI should be reviewed for validity and feasibility

Figure 3

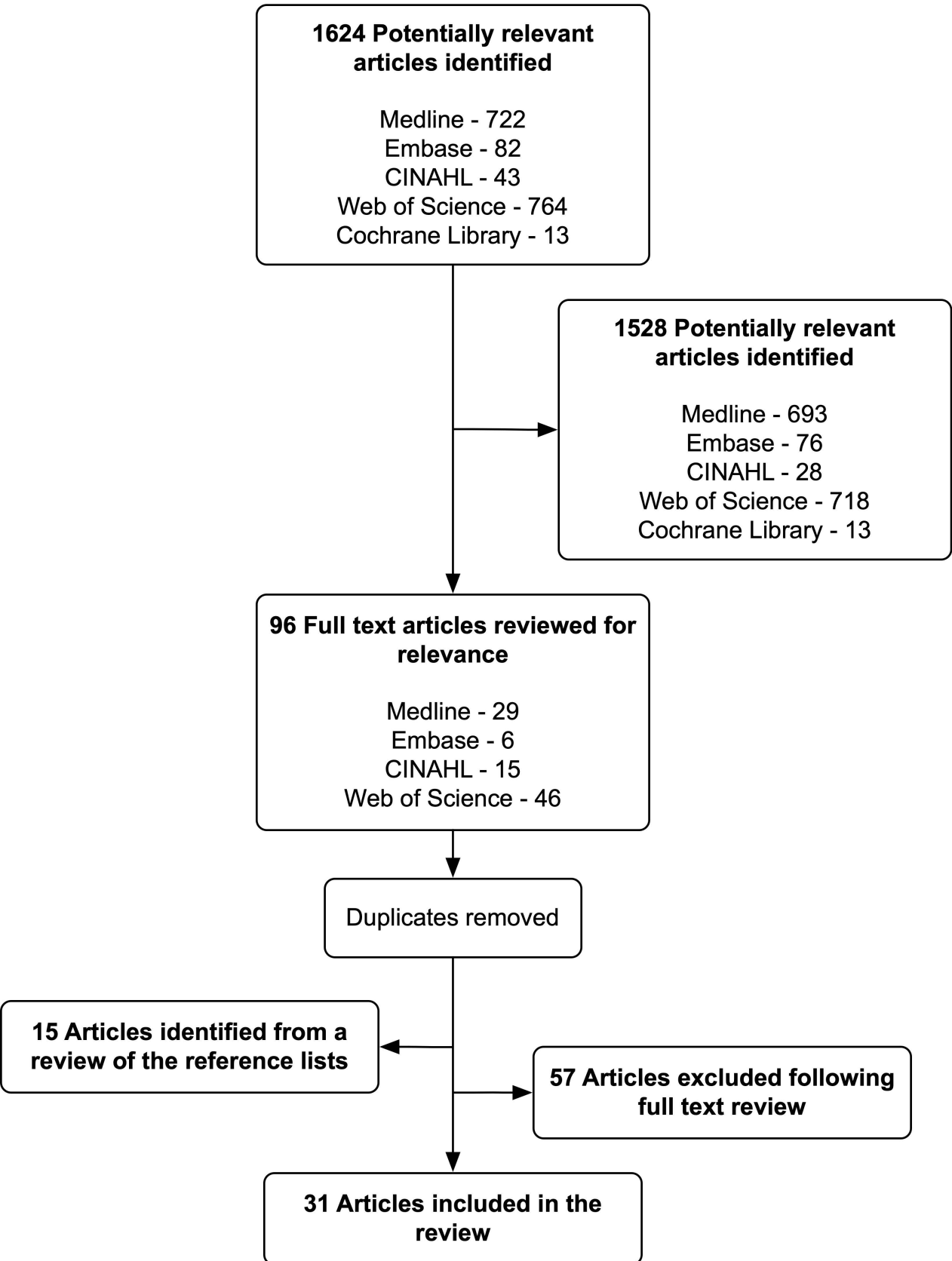


Table 1: Quality Indicator appraisal tool categories and criteria*

Category	No.	Subcategory Criterion
Relevance	R1	Significance: "The indicator covers aspects of quality of life, morbidity, or mortality."
	R2	Benefit: "Use of the indicator can have a positive effect on the quality of care."
	R3	Potential risks/side effects: "No risks are known/assumed which may result from the use of the indicator."
Scientific soundness	S1	Unambiguity of definitions: "The indicator is defined clearly and unambiguously."
	S2	Reliability: "It is a reliable measurement."
	S3	Risk adjustment: "The indicator is sufficiently adjusted to risk" (Are all factors that are not caused by the user taken into due account?)
	S4	Sensitivity: "The indicator provides sufficient sensitivity."
	S5	Specificity: "The indicator provides sufficient specificity."
	S6	Validity: "The indicator provides sufficient validity."
Feasibility	F1	Understandability and interpretability for patients and interested public
	F2	Understandability and interpretability for medical and nursing personnel
	F3	Possibility to influence the indicator manifestation: "The quality indicator refers to an aspect of care which can be influenced by the actors to be assessed."
	F4	Availability of data: "The data are documented by the service provider as a routine or can be collected with acceptable effort."
	F5	Data collection effort: "There is no data collection method available that provides at least equivalent results with less effort."
	F6	Implementation barriers: "Implementation barriers are unknown or covered by adequate measures."
	F7	Accuracy: "The correctness of the data can be verified."
	F8	Data integrity: "Is the individual data set intact?"
	F9	Completeness of the data: "Is it possible to verify that all occurring cases were recorded?"

*BQS – Institute of Quality and Patient Safety. QUALIFY: Instrument for the Assessment of Quality Indicators. 2007;(August)

Table 2: Inter-rater reliability analysis of individual appraisal by the Quality Indicator Appraisal Working Group

	Methodology	% agreement [p value (95% Confidence interval)]			Kappa [p value (95% Confidence interval)]		
Quality Indicator Appraisal Tool							
Relevance							
R1	Significance	90%	[<0.001	(0.8675 - 0.9350)]	0.90	[<0.001	(0.8587 - 0.9334)]
R2	Benefit	83%	[<0.001	(0.7934 - 0.8746)]	0.82	[<0.001	(0.7704 - 0.8669)]
R3	Potential risks/side effects	41%	[<0.001	(0.3887 - 0.4395)]	0.25	[<0.001	(0.2065 - 0.2840)]
Scientific Soundness							
S1	Unambiguity of definitions	81%	[<0.001	(0.7818 - 0.8465)]	0.80	[<0.001	(0.7664 - 0.8390)]
S2	Reliability	49%	[<0.001	(0.4614 - 0.5181)]	0.30	[<0.001	(0.2647 - 0.3434)]
S3	Risk adjustment	71%	[<0.001	(0.6789 - 0.7340)]	0.66	[<0.001	(0.6248 - 0.6975)]
S4	Sensitivity	80%	[<0.001	(0.7695 - 0.8395)]	0.78	[<0.001	(0.7426 - 0.8269)]
S5	Specificity	88%	[<0.001	(0.8502 - 0.9126)]	0.87	[<0.001	(0.8395 - 0.9093)]
S6	Validity	100%		(1)	1.00		(1)
Feasibility							
F1	Understandability and interpretability for patients and interested public	28%	[<0.001	(0.2670 - 0.2959)]	0.09	[<0.001	(0.0646 - 0.1076)]
F2	Understandability and interpretability for medical and nursing personnel	100%		(1)	1.00		(1)
F3	Possibility to influence the indicator manifestation	45%	[<0.001	(0.4286 - 0.4714)]	0.35	[<0.001	(0.3233 - 0.3835)]
F4	Availability of data	65%	[<0.001	(0.6434 - 0.6630)]	0.48	[<0.001	(0.4487 - 0.5134)]
F5	Data collection effort	22%	[<0.001	(0.2104 - 0.2345)]	0.01	[<0.001	(-0.0133 - 0.0235)]
F6	Implementation barriers	49%	[<0.001	(0.4803 - 0.5069)]	0.11	[<0.001	(0.0775 - 0.1503)]
F7	Accuracy	49%	[<0.001	(0.4803 - 0.5069)]	0.11	[<0.001	(0.0775 - 0.1503)]
F8	Data integrity	49%	[<0.001	(0.4765 - 0.5030)]	0.35	[<0.001	(0.3283 - 0.3695)]
F9	Completeness of the data	49%	[<0.001	(0.4765 - 0.5030)]	0.35	[<0.001	(0.3283 - 0.3695)]
RAND method							
Clarity		85%	[<0.001	(0.8079 - 0.8854)]	0.83	[<0.001	(0.7865 - 0.8786)]
Necessity		48%	[<0.001	(0.4663 - 0.5033)]	0.39	[<0.001	(0.3663 - 0.4196)]
Acceptability		90%	[<0.001	(0.8682 - 0.9363)]	0.90	[<0.001	(0.8585 - 0.9347)]
Technical Feasibility		47%	[<0.001	(0.4401 - 0.4958)]	0.32	[<0.001	(0.2735 - 0.3568)]

Table 3: Quality Indicator appraisal results

Quality Indicator for Review	QI Class	Relevance	Scientific Soundness	Feasibility	Appraisal Tool Score	Total criteria Applies	Applicable CPG	Supported in CPG	Clarity	Necessity	Acceptability	Technical Feasibility	RAND Score	Total categories ≥7
ACS/STEMI														
Patients with a provisional diagnosis of ACS/STEMI who had an ALS practitioner in attendance	Process	3.7	3.8	2.5	3.1	12	Yes	No	9.0	7.0	9.0	9.0	8.5	4
Patients with a provisional diagnosis of ACS/STEMI who had a set of defined cardiac risk factors assessed and recorded	Process	3.3	3.8	3.1	3.4	16	Yes	Yes	5.0	5.0	7.0	4.0	5.3	1
Patients with a provisional diagnosis of ACS/STEMI who had a 12 lead ECG obtained	Process	3.7	4.0	2.4	3.1	10	Yes	Yes	9.0	6.0	6.0	6.0	6.8	1
Patients with a provisional diagnosis of ACS/STEMI who were administered Aspirin	Process	3.7	4.0	3.1	3.5	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients with a provisional diagnosis of ACS/STEMI who were administered GTN	Process	3.7	4.0	3.1	3.5	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients with a provisional diagnosis of ACS/STEMI who were assessed for suitability for thrombolysis by defined checklist	Process	3.7	3.8	1.8	2.8	10	Yes	Yes	5.0	5.0	7.0	4.0	5.3	1
Patients with a provisional diagnosis of ACS/STEMI who were administered prehospital thrombolysis	Process	3.7	3.8	1.8	2.8	10	Yes	Yes	5.0	5.0	7.0	4.0	5.3	1
Patients with a provisional diagnosis of ACS/STEMI who were transported directly to a Facility with PCI capabilities	Process	3.3	4.0	1.8	2.8	9	Yes	Yes	5.0	5.0	7.0	4.0	5.3	1
Patients with a provisional diagnosis of ACS/STEMI who had EMS activation of the receiving Cath Lab	Process	3.7	3.8	1.8	2.8	10	Yes	Yes	5.0	1.0	1.0	4.0	2.8	0
Patients who received/met all components of a defined ACS/STEMI composite bundle score	Process	3.7	3.8	3.1	3.5	15	No	No	7.0	7.0	8.0	6.0	7.0	3
Acute Pulmonary Oedema														
Patients with a provisional diagnosis of APO who were administered GTN	Process	3.7	4.0	3.1	3.5	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients with a provisional diagnosis of APO who received CPAP	Process	3.7	4.0	2.6	3.3	11	Yes	Yes	9.0	9.0	9.0	2.0	7.3	3
Patients with a provisional diagnosis of APO who had a 12 lead ECG obtained	Process	3.7	4.0	2.5	3.2	11	Yes	Yes	9.0	5.0	7.0	4.0	6.3	2
Airway Management														
Patients who received a pre-ETI paralytic, following which there was a decrease in SpO2 > 10% from baseline/or decrease below 70% overall	Process	3.7	3.8	3.0	3.4	15	Yes	Yes	7.0	9.0	9.0	9.0	8.5	4
Patients successfully intubated by EMS personnel where EtCO2 monitoring was used post ETI	Process	3.7	3.8	3.0	3.4	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients successfully intubated via RSI by EMS personnel where a paralytic agent was administered post-ETI	Process	3.7	3.8	3.0	3.4	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients successfully intubated by EMS personnel where a sedative agent was administered post-ETI	Process	3.7	3.8	3.0	3.4	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients successfully intubated by EMS personnel where a mechanical ventilator was used post-ETI for ventilation	Process	3.7	3.8	3.0	3.4	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4

Patients in whom ETI was attempted by EMS personnel who had an alternative airway inserted as a final airway	Process	3.7	3.8	3.0	3.4	15	Yes	Yes	8.0	9.0	9.0	9.0	8.8	4
Patients in whom ETI was attempted by EMS personnel who had a surgical airway inserted	Process	3.7	3.8	3.0	3.4	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients successfully intubated by EMS personnel with an EtCO2 < 30 mmHg or > 50 mmHg post-ETI > 10 mins during EMS care	Process	3.7	3.8	3.0	3.4	15	Yes	Yes	7.0	9.0	9.0	9.0	8.5	4
Patients in whom RSI with ETI was unsuccessful when attempted by EMS personnel	Process	3.7	3.8	3.1	3.5	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients in whom Non-RSI ETI was unsuccessful when attempted by EMS personnel	Process	3.7	3.8	3.1	3.5	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients in whom RSI with ETI was successful when attempted by EMS personnel	Process	3.7	3.8	3.1	3.5	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Total number of patients successfully intubated via RSI by EMS personnel	Process	3.7	3.8	3.1	3.5	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients who received/met all components of the defined Airway management composite Bundle score	Process	3.7	3.8	3.1	3.5	15	No	No	7.0	8.0	9.0	7.0	7.8	4
Anaphylaxis														
Patients with a provisional diagnosis of Anaphylaxis and evidence of bronchoconstriction documented who were administered a B2 agonist	Process	3.7	3.8	3.0	3.4	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients with a provisional diagnosis of Anaphylaxis and evidence of bronchoconstriction documented who were administered an Anti-cholinergic bronchodilator	Process	3.7	3.7	3.0	3.3	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients with a provisional diagnosis of Anaphylaxis who were administered an antihistamine	Process	3.7	3.8	3.0	3.4	15	Yes	Yes	9.0	7.0	9.0	9.0	8.5	4
Patients with a provisional diagnosis of Anaphylaxis who were administered a corticosteroid	Process	3.7	3.8	3.0	3.4	15	Yes	Yes	9.0	6.0	9.0	9.0	8.3	3
Patients with a provisional diagnosis of Anaphylaxis and signs of a severe systemic response recorded who were administered IM Adrenaline	Process	3.7	3.8	3.0	3.4	15	Yes	Yes	6.0	9.0	9.0	9.0	8.3	3
Asthma/Bronchoconstriction														
Patients with a provisional diagnosis of Asthma/Bronchoconstriction with lung sounds assessed and documented (pre and post treatment)	Process	3.7	3.8	3.0	3.4	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients with a provisional diagnosis of Asthma/Bronchoconstriction with a SpO2 documented (pre and post treatment)	Process	3.7	3.8	3.0	3.4	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients with a provisional diagnosis of Asthma/Bronchoconstriction who were administered a B2 agonist bronchodilator	Process	3.7	3.8	3.0	3.4	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients with a provisional diagnosis of Asthma/Bronchoconstriction who were administered an anticholinergic bronchodilator	Process	3.7	3.7	3.0	3.3	15	Yes	Yes	8.0	9.0	9.0	9.0	8.8	4
Patients with a provisional diagnosis of Asthma/Bronchoconstriction who were administered a corticosteroid	Process	3.7	3.8	3.0	3.4	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients with a provisional diagnosis of Asthma/Bronchoconstriction recorded with documented severe wheezes/silent chest/BP < 90 mmHg systolic BP who were administered IM Adrenalin	Process	3.7	3.8	3.0	3.4	15	Yes	Yes	7.0	9.0	9.0	9.0	8.5	4

Patients who received/met all components of the defined Asthma/Bronchoconstriction composite bundle score	Process	3.7	3.8	3.1	3.5	15	No	No	9.0	9.0	9.0	9.0	9.0	4
Burns														
Patients with a provisional diagnosis of Burns with burns dressings applied	Process	3.3	3.8	3.0	3.3	14	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients with a provisional diagnosis of Burns with body surface area and burns type assessed and recorded	Process	3.7	3.8	3.0	3.4	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
General														
Serviceable suction unit devices available per defined area and/or time period	Structure	3.7	3.8	3.1	3.5	16	No	No	7.0	8.0	8.0	5.0	7.0	3
Serviceable 3 lead ECG monitoring devices available per defined area and/or time period	Structure	3.7	3.8	3.1	3.5	16	No	No	7.0	8.0	8.0	5.0	7.0	3
Serviceable 12 lead ECG monitoring devices available per defined area and/or time period	Structure	3.7	3.8	2.5	3.1	12	No	No	7.0	8.0	8.0	5.0	7.0	3
Serviceable portable oxygen cylinders available per defined area and/or time period	Structure	3.7	3.8	3.1	3.5	16	No	No	7.0	8.0	8.0	5.0	7.0	3
Serviceable Defibrillator/AED devices available per defined area and/or time period	Structure	3.7	3.8	3.1	3.5	16	No	No	7.0	8.0	8.0	5.0	7.0	3
Serviceable mechanical ventilators available per defined area and/or time period	Structure	3.7	3.8	2.5	3.1	12	No	No	7.0	8.0	8.0	5.0	7.0	3
Patients with reduced level of consciousness with a blood glucose measured	Process	3.7	3.8	3.1	3.5	16	Yes	Yes	9.0	9.0	8.0	9.0	8.8	4
Patients with a recorded SpO2 < 95% who were administered supplemental Oxygen	Process	3.7	4.0	3.0	3.4	15	Yes	Yes	9.0	9.0	8.0	9.0	8.8	4
Patients with a provisional diagnosis recorded	Process	3.7	3.8	3.0	3.4	15	No	No	9.0	9.0	9.0	9.0	9.0	4
Hypoglycaemia														
Patients with a blood glucose level < 5 mmol who were administered Glucose	Process	3.7	4.0	3.1	3.5	16	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients with a blood glucose level measured and recorded following Glucose administration	Process	3.7	4.0	3.1	3.5	16	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Neonate/Paediatric														
One min APGAR score assessed and recorded for newborn patients	Process	3.7	3.8	3.0	3.4	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Five min APGAR score assessed and recorded for newborn patients	Process	3.7	3.8	3.0	3.4	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Paediatric patients with a provisional diagnosis of Croup who were administered oral/inhaled steroids	Process	3.7	4.0	3.0	3.4	15	Yes	No	9.0	9.0	9.0	9.0	9.0	4
Paediatric patients with a provisional diagnosis of Croup who were administered nebulised Adrenalin	Process	3.7	3.8	3.0	3.4	15	Yes	No	9.0	9.0	9.0	9.0	9.0	4
Patient transportation to a facility with specialist Paediatric capabilities/resources	Process	3.3	3.7	2.3	2.9	8	Yes	Yes	7.0	9.0	9.0	7.0	8.0	4
Obstetrics														
Obstetric patients who deliver prior to EMS arrival	Process	3.7	4.0	3.0	3.4	15	Yes	Yes	9.0	6.0	8.0	9.0	8.0	3
Obstetric patients with postpartum haemorrhage who were administered TXA	Process	3.7	4.0	3.0	3.4	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Obstetric patients with a provisional diagnosis of Eclampsia or Pre-eclampsia who were administered Magnesium sulphate	Process	3.7	3.8	3.0	3.4	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Obstetric patients who deliver during EMS care	Outcome	3.7	4.0	3.0	3.4	15	Yes	Yes	9.0	8.0	9.0	9.0	8.8	4

OHCA														
Patients with a provisional diagnosis of OHCA with a witnessed collapse documented	Process	3.7	3.8	3.0	3.4	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients with a provisional diagnosis of OHCA who received documented bystander CPR	Process	3.7	3.8	3.0	3.4	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients with a provisional diagnosis of OHCA who received documented telephonic CPR advice	Process	3.7	3.8	3.0	3.4	15	Yes	Yes	7.0	9.0	9.0	3.0	7.0	3
Patients with a provisional diagnosis of OHCA with VF/VT as first presenting rhythm on arrival of EMS	Process	3.7	3.8	3.0	3.4	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients with a provisional diagnosis of OHCA with Asystole/PEA as first presenting rhythm on arrival of EMS	Process	3.7	3.8	3.0	3.4	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients with a provisional diagnosis of OHCA intubated with alternative airway device	Process	3.7	3.8	2.4	3.1	10	Yes	Yes	8.0	9.0	9.0	9.0	8.8	4
Patients with a provisional diagnosis of OHCA for whom resuscitation was cancelled prior to arrival at hospital	Process	3.7	3.8	3.1	3.5	15	Yes	Yes	9.0	8.0	9.0	9.0	8.8	4
Patients with a provisional diagnosis of OHCA who were transported to hospital (incl. ROSC and Non-ROSC patients)	Process	3.7	4.0	3.0	3.4	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients with a provisional diagnosis of OHCA with ROSC at hospital handover	Process	3.3	4.0	2.9	3.3	13	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients with a provisional diagnosis of OHCA with VF/VT at hospital handover	Process	3.3	4.0	2.9	3.3	13	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients with a provisional diagnosis of OHCA with Asystole/PEA at hospital handover	Process	3.3	4.0	3.0	3.4	14	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients with a provisional diagnosis of OHCA with survival to Emergency Centre discharge	Process	3.3	3.8	1.6	2.6	8	Yes	Yes	7.0	9.0	9.0	2.0	6.8	3
Patients with a provisional diagnosis of OHCA with survival to hospital discharge	Outcome	3.3	3.8	1.6	2.6	8	Yes	Yes	7.0	9.0	9.0	2.0	6.8	3
Pain Management														
Patients with level of Pain measured via defined pain score	Process	3.7	3.8	3.1	3.5	16	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients with a defined pain score threshold who were administered analgesia	Process	4.0	3.8	3.0	3.4	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients with level of pain measured via defined pain score following analgesia administration	Process	4.0	3.8	3.1	3.5	16	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Seizures														
Patients with a provisional diagnosis of Seizures with a blood glucose measured and recorded	Process	3.7	3.8	3.0	3.4	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients with a provisional diagnosis of Seizures who were administered an antiepileptic for ongoing Seizures	Process	3.7	3.8	3.0	3.4	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Stroke/TIA														
Patients with a provisional diagnosis of Stroke/CVA/TIA with a blood glucose measured and recorded	Process	3.7	3.8	3.0	3.4	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients with a provisional diagnosis of Stroke/CVA/TIA with a Stroke screening assessment performed (e.g.: FAST)	Process	3.7	3.8	3.0	3.4	15	Yes	Yes	9.0	9.0	9.0	7.0	8.5	4
Patients with a provisional diagnosis of Stroke/CVA/TIA with serial blood pressure measurements recorded (X3)	Process	3.7	4.0	3.0	3.4	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4

Patients with a provisional diagnosis of Stroke/CVA/TIA delivered to a specialist Stroke Centre	Process	4.0	3.8	1.6	2.8	9	Yes	Yes	7.0	9.0	9.0	1.0	6.5	3
Patients with a provisional diagnosis of Stroke/CVA/TIA with direct delivery to CT scan	Process	3.3	3.8	2.3	3.0	8	Yes	Yes	7.0	9.0	9.0	2.0	6.8	3
Patients who received/met all components of the defined Stroke/CVA/TIA composite bundle score	Process	3.7	3.8	3.0	3.4	15	No	No	7.0	7.0	9.0	7.0	7.5	4
Trauma														
Patients designated as a trauma case with entrapment on scene documented	Process	3.7	3.8	3.0	3.4	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients designated as a trauma case with a BP < 90 mmHg	Process	3.7	3.8	3.0	3.4	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients designated as a trauma case with partial/full amputation who had a tourniquet applied	Process	3.7	4.0	3.0	3.4	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients designated as a trauma case with a femur fracture and traction splint use	Process	3.7	3.8	3.0	3.4	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients designated as a trauma case with a BP < 90 mmHg who were administered TXA	Process	3.7	3.8	3.1	3.5	15	Yes	Yes	9.0	9.0	9.0	9.0	9.0	4
Patients designated as a trauma case with direct transportation to a specialist Trauma Centre	Process	3.7	4.0	2.3	3.1	9	Yes	Yes	7.0	9.0	9.0	9.0	8.5	4
Adverse Events														
Number of patient deaths while in EMS care	Sentinel Event	3.7	4.0	2.4	3.1	10	No	No	7.0	9.0	9.0	8.0	8.3	4
Number of defined Adverse Events reported during EMS care	Sentinel Event	3.7	3.8	2.5	3.1	12	No	No	7.0	9.0	9.0	7.0	8.0	4
Number of defined equipment/technical failures reported during EMS care	Sentinel Event	3.7	3.8	2.5	3.1	12	No	No	7.0	9.0	9.0	6.0	7.8	3
Number of accidental or unexpected extubations reported during EMS care	Sentinel Event	3.7	3.8	2.5	3.1	12	No	No	8.0	9.0	9.0	4.0	7.5	3
Number of patients with a decrease in GCS of 3 or more points during EMS care	Sentinel Event	3.7	3.8	2.5	3.1	12	No	No	9.0	9.0	9.0	8.0	8.8	4
Number of defined failed intubation attempts	Sentinel Event	3.7	4.0	2.5	3.2	11	No	No	9.0	9.0	9.0	6.0	8.3	3
Total number of patient injury reports during EMS care	Sentinel Event	3.7	3.8	2.5	3.1	12	No	No	7.0	9.0	9.0	7.0	8.0	4
Number of EMS staff on-duty injury reports	Sentinel Event	3.7	3.8	2.5	3.1	12	No	No	7.0	9.0	9.0	7.0	8.0	4
Number of defined medication errors during EMS care	Sentinel Event	3.7	3.8	2.5	3.1	12	No	No	7.0	9.0	9.0	6.0	7.8	3
Communications/Dispatch														
Number of cases compliant with defined ALS Dispatch criteria	Structure	3.7	4.0	3.1	3.5	15	No	No	8.0	8.0	9.0	6.0	7.8	3
Number of cases with call processing time within defined limits	Structure	3.7	3.8	3.1	3.5	15	No	No	9.0	7.0	9.0	7.0	8.0	4
Number of Service Call Centre calls received per 10000 population	Structure	3.7	4.0	3.0	3.4	15	No	No	7.0	9.0	9.0	5.0	7.5	3
Number of unanswered/missed calls to the Service Call Centre	Structure	3.7	4.0	3.1	3.5	15	No	No	7.0	9.0	9.0	6.0	7.8	3
Number of cases with a delay in dispatch and/or response time waiting for a police/security escort	Process	3.7	4.0	2.6	3.3	11	No	No	8.0	9.0	9.0	7.0	8.3	4

Appraisal Tool Score < or on threshold of validity score

RAND Method Score < or on threshold of validity score

Table 4: Literature review of evidence base

Indicator Category	Indicator subcategory	Total QIs	Indicator Type				Level of Evidence										Ref
			Structure	Process	Outcome	Sentinel Event	1a	1b	1c	2a	2b	2c	3a	3b	4	5	
Clinical	Acute Coronary Syndromes	25		23	2					4	5				2	14	1–6
	Airway management	8		8							2		1		1	2	2,7–11
	Acute Pulmonary Oedema	2		2						2							5
	Asthma	10		10						1						9	2,3,11
	General	18		15	3					2					4	12	2,6–9,12–19
	Hypoglycaemia	3		3												3	3
	Out of hospital cardiac arrest	44	4	38	2					2					3	39	2,3,5,7–9,13,18,20–22
	Pain management	1		1												1	12
	Seizures	2		2						2							11
	Stroke	11		11							3					8	3,23–25
	Trauma	16	3	11	2					4			5			6	2,5,9,12,19,26
Non-clinical	Adverse Event	25				25					9			11		5	7,8,10,14,15,19,27
	Deployable resources	15	13	2	2										5	13	18,28,29
	Dispatch/Call times	90	7	73	6					3	1		26	17	4	39	2,7–9,12,15,16,19,25,30
	Documentation	16	3	13								2		2	3	11	7–9,12,15,18,19,31
	Employee focused	16	16											2	2	12	7–9,13,18,29
	Service user rating/satisfaction	9		6	3										1	8	13,18,29
Total		311	46	218	20	25	0	0	0	20	20	2	32	32	25	182	
%			15%	70%	6%	8%	0%	0%	0%	6%	6%	1%	10%	10%	8%	59%	

2a. Systematic review of 2b and better studies
2b. Retrospective cohort study or prospective cohort with poor follow-up/low quality RCT
2c. “Outcomes” Research; Ecological studies
3a. Systematic review of 3b and better studies
3b. Non-consecutive cohort study/Individual case control study
4. Case series
5. Expert opinion

Table 5: Qualitative analysis of the Working Group discussion			
Methodology	**Text Reference**	**Sub-category**	**Supporting Quote**
Quality Indicator appraisal tool	1.1	Relevance	"For me, because practically zero clinical indicators are used or reported publicly by EMS [Emergency Medical Services] in South Africa, their relevance wand significance and benefit was naturally going to be scored high"
	1.2	Usability	"Whenever I was rating a category that I used or drew information from the data dictionary, there was always sufficient information that left no doubt that it was well planned for or accounted for. The difficult part was knowing how much variation there would be in different EMS organizations in South Africa in how they would be able to extract this information and put it to use"
	1.3	Context	"Whatever indicators are used by a service, it's important that they do a feasibility assessment of what's possible for them to achieve. We may be able to say overall, like these will work for South Africa in general, but when it comes to actual implementation, a service is going to have to understand its surroundings and the types of patients it sees"
	1.4		"Like, the indicators involving direct transport to a CT [Computed Tomography] scanner for Stroke patients, or to PCI [Percutaneous Coronary Intervention] facilities for STEMI [ST Elevation Myocardial Infarction], those will only be applicable to certain metropolitan areas, and probably only for certain private services as well. It won't be a general indicator for everyone to use"
	1.5	Quality system	"This is a complete mind shift from what we currently know and how we measure quality in South Africa. If a service is serious about implementing these, even it's just a few, they're going to have to admit that it's going to take an overhaul in their quality system, and that it's likely going to need more resources than what they dedicate to measuring response times at the moment"
	1.6		"Outside of a few of the large private services, the provincial services are going to have to ramp up the effort around measuring quality. As simple and as easy a system that these indicators are, there's probably not many of the provincial services that are ready to implement them"
RAND method	2.1	Methodology	"You really get to see how these will be used from a practical point of view. I can see the benefit of how a simple system that's objective can make the world of difference. It's not like how I used to remember it when we checked the case sheets, and it depended on how you felt at the time"
	2.2		"Doing the data extraction made a big difference, because I remember, especially for the sentinel event indicators, I scored them quite low with the appraisal tool, but when we went through them and applied them to actual cases, it was much simpler than I thought it would be and so I scored them higher after being able to actual do the extraction"
	2.3	Technology	"I think applying these indicators would be way easier with an electronic patient report form. It's going to take way more effort in doing it manually, but I can still see the benefits even if it's done this way"
	2.4	Quality system	"I think when you're sitting down and applying the indicators to case sheets, the system does seem simple and straightforward enough to use. But what do you do from there? It's going to be a logistical challenge to get the paperwork together to do the assessment, but I feel like the bigger challenge is using the information we learn, it's just as important as getting the information"
	2.5	Transparency	"It seems like it's going to be easy to game the system. Like how I know the guys have done the things that they've written down. What sort of mechanism is there for to check that they've been truthful in their notes, especially if they now know they're being watched"
	2.6	Technology	"I think [participant] was right about the electronic record, because we can build checks and balances into that sort of thing to monitor truthfulness I suppose, also like [respondent] mentioned. That also solves the legibility issue and whether or not enough information has been written. Look at when we used the poor documentation examples, it was difficult to apply the indicators to those just because you didn't always have the right information to go on"

BMJ Open Quality

Understanding quality systems in the South African prehospital emergency medical services: a multiple exploratory case study

Ian Howard,[1,2] Peter Cameron,[3] Lee Wallis,[2,4] Maaret Castrén,[5] Veronica Lindström[6]

To cite: Howard I, Cameron P, Wallis L, *et al*. Understanding quality systems in the South African prehospital emergency medical services: a multiple exploratory case study. *BMJ Open Quality* 2020;**9**:e000946. doi:10.1136/bmjoq-2020-000946

► Additional material is published online only. To view please visit the journal online (http://dx.doi.org/10.1136/bmjoq-2020-000946).

Received 14 February 2020
Revised 24 April 2020
Accepted 1 May 2020

For numbered affiliations see end of article.

Correspondence to
Mr Ian Howard;
ianhoward@outlook.com

ABSTRACT

Introduction In South Africa (SA), prehospital emergency care is delivered by emergency medical services (EMS) across the country. Within these services, quality systems are in their infancy, and issues regarding transparency, reliability and contextual relevance have been cited as common concerns, exacerbated by poor communication, and ineffective leadership. As a result, we undertook a study to assess the current state of quality systems in EMS in SA, so as to determine priorities for initial focus regarding their development.

Methods A multiple exploratory case study design was used that employed the Institute for Healthcare Improvement's 18-point Quality Program Assessment Tool as both a formative assessment and semistructured interview guide using four provincial government EMS and one national private service.

Results Services generally scored higher for *structure* and *planning*. *Measurement* and *improvement* were found to be more dependent on utilisation and perceived mandate. There was a relatively strong focus on clinical quality assessment within the private service, whereas in the provincial systems, measures were exclusively restricted to call times with little focus on clinical care. *Staff engagement* and *programme evaluation* were generally among the lowest scores. A multitude of contextual factors were identified that affected the effectiveness of quality systems, centred around leadership, vision and mission, and quality system infrastructure and capacity, guided by the need for comprehensive yet pragmatic strategic policies and standards.

Conclusion Understanding and accounting for these factors will be key to ensuring both successful implementation and ongoing utilisation of healthcare quality systems in emergency care. The result will not only provide a more efficient and effective service, but also positively impact patient safety and quality of care of the services delivered.

INTRODUCTION

The importance of quality systems in the prehospital emergency care (PEC) setting is becoming increasingly recognised given that the delivery of PEC services is frequently provided against the backdrop of demanding environments, often with limited resources, and for patients of varying and unpredictable acuity.[1–4] As PEC focused tools for measuring and understanding patient safety and quality of care have been developed and implemented, so too has the recognition of the importance of formal systems for governing such activities.[4–9]

In South Africa (SA), a mix of government-funded and private emergency medical services (EMS) deliver PEC across the country.[10] Within these services, quality systems are in their infancy.[11] Among PEC clinicians, the general perception of EMS quality systems in the country is poor.[11] Concerns regarding system transparency, reliability and contextual relevance have been cited as common reasons for this.[11] These issues have been exacerbated by apparent poor communication, ineffective leadership and a historical association of the use quality systems as a punitive mechanism.[11]

Recent National Department of Health policy reviews have highlighted the importance of systems for developing, implementing and monitoring the quality of healthcare in the country.[12] While significant advances have been made in improving the scope of practice, training and education of PEC clinicians, little has been done towards developing formal quality systems aimed at assessing and maintaining standards of quality of care and patient safety in the PEC setting in SA.

There are a multitude of potential factors that could affect these systems as a whole. Therefore, in order to determine priorities for focus regarding their development and improvement, it is important to first understand the current state of EMS quality systems in the country. Given this need, we undertook a study to assess prehospital EMS quality systems in SA.

METHODS

A multiple exploratory case study design was used in order to achieve the study aim.[13 14]

For the purposes of this study, a case was defined as the quality programme or system of performance measurement of a participating service. The definition of a case was purposely kept broad given that quality measurement by EMS in SA is limited and the existence or scope of formal quality systems likely to be equally limited.[11] The quality systems of four provincial government EMS and one national private EMS organisation were used for the purposes of this study.

Primary data collection

Multiple sources and data types were used and collected to achieve the study aim.[14] The Institute for Healthcare Improvement's Quality Program Assessment Tool was employed as the primary means of data collection (online supplementary file 1). The tool uses a categorical rating scale of 0–5 to answer 18 key questions across six broad criteria, namely:

- Quality structure.
- Quality planning.
- Quality measurement.
- Quality improvement activities.
- Staff involvement in the quality programme.
- Evaluation of the quality programme.

The tool was used as both a formative assessment for each participating service's quality programme, as well as a semistructured interview guide to further explore the results obtained from the formative assessment. Data were collected via interviews of directors and leaders of the participating services with intricate knowledge of their respective service's operations. To maintain anonymity, their specific titles have been omitted. All interviews were conducted in English and recorded for transcription and analysis. Reflective notes were maintained during each interview, and immediately after, for verification of the interview results during analysis.

Secondary data collection

Multiple sources of secondary data were collected to support the primary data, grouped into two categories. Category A secondary data were made up of the results of a targeted literature review to identify policy-focused guidance for EMS organisations in SA regarding the implementation of a quality programme; and/or the development, implementation and utilisation of methods to assess quality of care. A search of several key websites was conducted, including: The Health Professions Council of SA—the healthcare licensing body of the South African National Department of Health (SADoH); the SADoH; and Statistics South Africa—the statistical service of the South African national government. Category B secondary data were made up of publicly accessible quality and/or performance reports published by the participating services.

Setting and population

The delivery of prehospital emergency medical care in SA is based on a three-tiered system of basic, intermediate and advanced life support levels of qualification. Each level is licensed for independent practice and governed by a national registration board, yet delivered primarily through provincial government-funded EMS, with several private EMS located in the larger cities across the country servicing medical insurance clients. Given the variations in geography and population distribution across SA, the four provincial prehospital emergency medical services of KwaZulu Natal, Western Cape (WC), Limpopo (LP) and North West (NW) provinces were purposively selected to be as inclusive of this variation as possible (figure 1). There is limited evidence to suggest that private EMS in SA are more advanced regarding the utilisation of quality assessment tools and frameworks.[11] As a result, a national private EMS organisation was additionally included as part of the multiple case review.

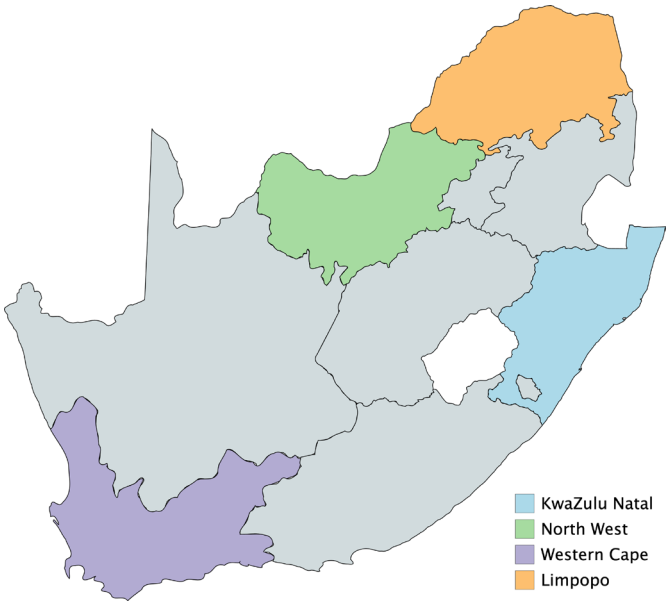


Figure 1 Participating provincial emergency medical services.

Data analysis

For the primary data collection, descriptive statistics were used to describe and summarise the categorical-based formative assessment. Conventional content analysis, as described by Hsieh and Shannon, was used to sort and analyse the interview data.[15] Prior to analysis, each interview transcript was reread for content familiarisation. First-level coding was conducted through the extraction of meaning units from each transcript and summarised into codes using open coding. Once completed, similar codes were combined and organised to develop clustered subcategories. Throughout the first-level coding and subcategory development, the reflective notes were referenced for verification. Interview transcriptions were analysed using MAXQDA (MAXQDA, 2016; Sozialforschung GmbH, Berlin, Germany).

For the secondary data collection, document analysis as described by Bowen was used to sort and analyse the supporting data.[16] Eligible documents were retrieved and

scanned for relevance based on the inclusion criteria. A full-text review was conducted if the document remarked on quality systems, quality of care or quality indicators (QIs). Supporting excerpts, quotations or passages that made reference to EMS in general or by case example were extracted and synthesised. Data were extracted using a standardised data extraction form (Microsoft Excel 2010; Redwood, Washington USA)

Triangulation

The utilisation and triangulation of multiple methods and data sources attempt to safeguard against potential implications that findings are simply an artefact of a single method, a single source or a single investigator's bias.[16] Therefore, for the purposes of this study, multiple methods were used to ensure internal validity and trustworthiness of the overall study, as described by Guba, and included[17]: the quality programme formative assessment and supporting documentation; the in-depth qualitative exploration of the assessment via recorded interviews and transcripts; reflective notes; national and/or provincial legislation, policies and directives; and published organisational performance reports.

Consent for participation was provided by each of the participating services and individuals prior to data collection.

Patient and public involvement

No patients were involved in the development of the research question, study design or data collection. The results of the study will be disseminated to participants in the form of a peer-reviewed publication, once complete.

RESULTS

The services included for the case review covered a multitude of social and healthcare demographics found across the country (table 1). There was equal variation in the outcomes of the formative assessment, where services generally scored higher for *structure* and *planning* (table 2). *Measurement* and *improvement*, however, were found to be more dependent on the services' utilisation and perceived mandate. There was a relatively strong focus on clinical quality assessment and improvement within the private service, whereas in the provincial systems, QIs reported were exclusively restricted to call times and available vehicle resources, with little to no focus on clinical care. Given the limited scope of QIs measured and reported, it was somewhat predictable that *staff engagement* and *programme evaluation* were generally among the lowest scores for the participating services (see table 3 for subcategories and supporting quotes from the qualitative analysis of the quality programme assessment).

Primary data

South Africa population: 57 458 000.

No. of households: 16 671 000.

Public transport use: 46.2%.

Western Cape

Population: 6 650 000 (11.6%).

No. of households: 1 877 000 (11.3%).

Public transport use: 44.7%.

The provincial service's higher points in the formative assessment were largely within *structure* and *planning*, where a hybrid centralised/decentralised system of subdistrict engagement with two 'centralised' quality nodes (ie, one urban and one rural) was employed for the services quality system. Within this system were staff primarily dedicated to quality assessment and monitoring. Despite this strength, it was acknowledged that a lack of higher level leadership had had an impact on the programme (1.1). Similarly, while a comprehensive quality plan existed, it was acknowledged to be outdated and inconsistently reviewed and/or updated.

The most significant points to emerge regarding *measurement* and *improvement* were in relation to the services understanding of its mandate, and the view that the service operated as a transport company more than a medical company, especially given the sociopolitical history of the region (1.2, 1.3). In light of this, it was felt that reporting on time-based measures of performance was wholly appropriate. Similarly, much of the focus on improvement activities were centred around transport and improving interfacility transport booking and operations in particular. The service acknowledged that improvements could be made in terms of staff engagement; however, they felt their public engagement had improved significantly in recent years. Unfortunately, the primary driver for this had been an exponential increase in attacks on ambulances in the community (1.4).

KwaZulu Natal

Population: 11 245 000 (19.5%).

No. of households: 2 905 000 (17.4%).

Public transport use: 40.9%.

The service scored low for *structure* in the formative assessment, compared with the other services. The decentralised approach towards measurement and evaluation adopted made coordination difficult, which was further exacerbated by the perceived rudimentary means with which data were captured and shared (2.1). While the service acknowledged the lack of described roles, responsibilities and accountabilities within its quality plan, the content of the plan was otherwise described as comprehensive and underwent regular evaluation and update [2.2].

The service scored highest in *measurement*, where a strong focus was placed on continuous monitoring for trend analysis. As with the WC, the focus was strongly associated with its perceived mandate and service utilisation (2.3, 2.4). The service scored low for staff and public engagement where it was acknowledged that while some effort was made towards this, there was still much to be improved on (2.5, 2.6).

Table 1 Selected social and health demographics of participating provinces

	South Africa		Western Cape		KwaZulu Natal		Limpopo		North West	
Metric	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Wealth quintiles										
Lowest				2.7		25.5		27.6		14.7
Second				7.5		22.6		40.7		29.1
Middle				11.8		20.6		17.8		30.3
Fourth				32.1		15.8		7.7		18.7
Highest				45.8		15.4		6.2		7.3
Primary source of income										
Salary		58.6		72.9		54.6		42.8		53.2
Remittances		9.4		2.7		10.7		16.3		12.2
Pensions		2.2		4.3		1.7		1.2		1.8
Grants		19.9		10.3		24.6		30.4		24.2
Other sources		9.9		9.9		8.4		9.3		8.5
Household type										
Other		0.8		1.4		0.2		0		0
Informal		13.1		19		6.7		4.9		18.6
Traditional		5		0		12.6		2.2		0.5
Formal		81.1		79.6		80.5		93		80.9
Household services										
Household piped water		89		98.7		86.6		74.1		85.2
Household mains electricity		84.7		87.9		83.5		92.7		83.7
Household sanitation		83		93.8		81.4		58.9		70.6
Medical insurance coverage										
Male				36.3		11.3		13.4		15.7
Female				30.1		12.7		10.5		14.9
Healthcare facility consulted first										
Public clinic		64.9		43.7		73.9		78.1		72.3
Public hospital		6.1		12.4		4.7		7.8		2.6
Other public institution		0.5		0.1		0.4		0.3		0.6
Private clinic		1.3		1.2		0.9		0.8		1
Private hospital		1.6		2.3		1.1		0.5		0.7
Private doctor		24.2		39.8		18.3		11.1		19.7
Traditional healer		0.7		0.2		0.4		1		0.3
Pharmacy		0.4		0.3		0.2		0.3		0.3
Other		0.4		0.1		0.1		0.3		2.6
Problems in accessing healthcare										
Obtaining permission				7.2		23.9		22.8		10.6
Money for payment				16		27.8		37.5		32.9
Distance to travel				11.3		29.7		33.1		31.8
Not wanting to go alone				8.6		24.6		18.8		17.4
Satisfaction with healthcare facilities										
Public/government										
Very satisfied		53.8		47.9		50.8		72.1		40.3
Somewhat satisfied		26.5		21.6		31.7		15.7		26
Neither satisfied nor dissatisfied		9.5		11.1		11.1		5.1		15.1
Somewhat dissatisfied		5		8.9		3.8		4.2		5.3
Very dissatisfied		5.2		10.5		2.6		2.9		13.4

Continued

Table 1 Continued

Metric	South Africa		Western Cape		KwaZulu Natal		Limpopo		North West	
	N	%	N	%	N	%	N	%	N	%
Private										
Very satisfied		92.6		93.7		89.3		91.9		89
Somewhat satisfied		5		3.7		7.4		5.8		9.1
Neither satisfied nor dissatisfied		1.3		0.9		2.7		0		0.3
Somewhat dissatisfied		0.5		0.9		0.3		0.3		1.3
Very dissatisfied		0.6		0.8		0.4		2		0.4
Distribution of death										
0				3.3		3.8		0.5		6.3
1–14				1.5		2.9		0.5		3.5
15–44				24.3		30.7		21.8		27.4
45–64				30.6		26.7		31		30
65+				40.1		35.6		46.3		32.7
Unspecified				0.2		0.2		0		0.1
Leading natural cause of death (all ages)										
TB	1st	6.5	5th	5.1	1st	7.6	4th	5.5	1st	7.4
Diabetes	2nd	5.5	1st	7.7	2nd	7.4	2nd	6.3	6th	4.7
Other forms of heart disease	3rd	5.1	10th	3.1	3rd	66	8th	3.3	3rd	5.5
Cerebrovascular diseases	4th	5.1			5th	6	3rd	5.8	7th	4.3
HIV	5th	4.8	2nd	6.2	4th	6.2	7th	3.4	8th	3.4
Hypertensive diseases	6th	4.4	9th	3.9	7th	3.8	5th	5.4	2nd	5.8
Influenza and pneumonia	7th	4.3					1st	7.6	5th	5
Other viral diseases	8th	3.6			8th	3.6	6th	5.2	4th	5
Ischaemic heart diseases	9th	2.8	3rd	6	9th	2.8				
Chronic lower respiratory diseases	10th	2.8	6th	4.9					10th	2.7
Malignant neoplasm—digestive			7th	4.6	10th	2.2				
Malignant neoplasm—intrathoracic			8th	4.6						
Intestinal infectious diseases							9th	2.9		
Renal failure							10th	2		
Other disorders involving immune mechanism									9th	3.2
Non-natural causes of death (all ages)										
Transport accidents				7.5		13		31.8		16.1
Other accidental injuries				64		67.1		56.1		65.3
Intentional self-harm				0.4		2		0.4		0.2
Assault				24.4		13.7		8		12.7
Complications of medical and surgical care				2.1		1.8		1.2		1.4

HIV, Human Immunodeficiency Virus; TB, tuberculosis.

Limpopo

Population: 5 854 000 (10.2%).

No. of households: 1 579 000 (9.3%).

Public transport use: 41.9%.

The LP EMS quality system scored relatively highly within the *structure* and *planning* categories of the formative assessment. There was a strong focus on strategic planning, where their quality system and planning were firmly entrenched into the broader provincial health structures (3.1). The importance of this relationship with the provincial health system was emphasised as a driver for potential improvements in service quality monitoring (3.2).

It was acknowledged that much could be done to improve *quality measurement* and *improvement* within the service, which scored lower in the formative assessment. The service focused primarily on response time targets and complaints for measuring and reporting of quality and performance (3.3). The notion of relationships was echoed in these sections, where feedback from the facilities the service interacted with were too seen as an important measure of quality.

Table 2 Quality programme formative assessment

No.	Quality programme assessment tool question	WC	KZN	NW	LP	Private
Quality structure						
A.1	Does the organisation have an organisational structure in place to plan, assess and improve the quality of care?	2	1	1	3	5
A.2	Have adequate resources been committed to fully support the quality programme?	4	2	0	2	4
A.3	Do the leadership support the quality programme?	3	1	1	3	5
Subtotal (max=15)		9	4	2	8	14
Quality planning						
B.1	Does the organisation have a comprehensive quality improvement/ management plan?	2	3	1	3	2
B.2	Does the organisation have clearly described roles and responsibilities for the quality programme?	4	1	0	1	4
B.3	Does the work plan specify timelines and accountabilities for the implementation of the quality programme?	4	1	0	3	3
Subtotal (max=15)		10	5	1	7	9
Quality measurement						
C.1	Are appropriate outcome and process quality indicators selected in the quality programme?	1	3	1	1	2
C.2	Does the organisation regularly measure the quality of care?	1	3	0	1	3
C.3	Are processes established to evaluate, assess and follow-up on quality data?	3	3	0	2	3
Subtotal (max=15)		5	9	1	4	8
Quality improvement activities						
D.1	Does the organisation conduct specific quality activities and projects to improve the quality of care?	3	1	1	2	3
D.2	Are quality improvement teams formed for specific projects?	3	1	0	2	4
D.3	Are systems in place to sustain quality improvements?	3	3	0	2	2
Subtotal (max=15)		9	5	1	6	9
Staff involvement						
E.1	Are staff routinely educated about the programme's quality programme?	2	1	0	2	1
E.2	Does the organisation routinely engage all levels of staff in quality programme activities?	2	3	0	2	2
E.3	Are patients involved in quality-related activities?	3	0	0	2	3
Subtotal (max=15)		7	4	0	6	6
Evaluation of quality programme						
F.1	Is a process in place to evaluate the quality programme?	3	3	0	2	1
F.2	Does the quality programme integrate findings into future planning?	3	3	0	2	3
F.3	Does the programme have an information/data system in place to track patient care and measure quality indicators?	2	3	0	1	3
Subtotal (max=15)		8	9	0	5	7
Total (max=90)		48	36	5	36	53

0—no plan/structure/process.
1—limited plan/structures/process in place.
2—early implementation.
3—full implementation.
4—developing systematic approach to quality.
5—full systematic approach to quality.
KZN, KwaZulu Natal; LP, Limpopo; NW, North West; WC, Western Cape.

Table 3 Qualitative exploration of the quality programme assessment

Participating service and interviewee	Text reference	Subcategory	Supporting quote
1. Western Cape Director-level participant	1.1	Leadership	"We're at the disadvantage where [the director] who normally drives this [quality] has been away for probably almost two years now and as a consequence, much of these questions where we had answered reasonably well before, realistically speaking we are nowhere near that because the person responsible for coordinating that has not been here"
	1.2	Mandate	"I'm of the view that in the South African context, we are a logistics company, we are not a medical company…we are a transport system"
	1.3	Historical factors	"Because of the nature of the South African services, because of the socio-political aspects of the way cities are structured in South Africa, particularly in Cape Town, response time performance had to be prioritised, due to spatial divide… our cities are racially designed which means in a post-democratic country, in a way to break that up, you have to put a transport system in place, so that the racial divide, the inequity isn't perpetuated, and where you don't have a public transport system, when it comes to healthcare, that's the primary purpose of ambulance service"
	1.4	Safety	"so, what has happened as a consequence of safety, as a consequence of all of these ambulance attacks, one of the things we've had to do, we've had to engage with the community more often, so what is happening relatively frequently, is we attend patient health forums. The district managers must attend or send a representative to every community health forum meeting or community safety forum meeting. So, at these sessions, a patient voice invariably comes through"
2. KwaZulu Natal Deputy Director-level participant	2.1	Structure	"EMS in KwaZulu Natal has a provincial M&E (measurement and evaluation) manager and then one FIO (facility information officer) per district. We have eleven districts in total. Information and quality currently measured are focused on service delivery. The quality of medical care provided to patients is an area that is currently lacking. A set of indicators is reported on monthly by each district using an excel spreadsheet, this is a huge challenge as data is manually captured at each level from the source to final consolidation and reporting"
	2.2		"We do have a quality plan in place. This is reviewed annually. The plan takes into account available resources, available budget and timeframes. The plan contains mainly issues around service delivery and strategies to improve service delivery. The plan is reviewed by the EMS management team which includes the EMS provincial management team and EMS district managers."
	2.3	Mandate	"When we measure quality of services, we look at the national norms currently available together with the demand for services. Firstly, we look at available resources and how we compare to the 1 ambulance per 10 000 population national norm. Then we look at the demand for services—what the available resources had to attend to. And then we look at the percentage P1 cases responded to within the national norms. These are all viewed as a piece of the complete puzzle and should not be measured or reported on independently as the picture will be incomplete. The assumption is that, if you have 1 ambulance per 10 000 population then you should be able to achieve the response time norms to P1 cases taking into account your case load has not spiked due to any unforeseen circumstance"
	2.4		"This is the focus of our performance measured on a continuous basis where trends are monitored on a monthly, quarterly and annual basis. Other quality indicators are measured as and when required, particularly if we have a special project or intervention in place."
	2.5	Engagement	"performance results are presented at our EMS management team forum and distributed to districts by the provincial M&E manager. EMS district managers are encouraged to present their performance to staff at all levels within the districts, but this is not happening in all districts"
	2.6		"As EMS we do not have much public engagement regarding our performance however our performance reports are included in the departmental annual reports which are public documents. These are also discussed at public imbizo events where the public has an opportunity to pose questions, concerns, comments to the departments senior management where EMS is represented"

Continued

Table 3 Continued

Participating service and interviewee	Text reference	Subcategory	Supporting quote
3. Limpopo Director-level participant	3.1	Strategic planning	"The EMS plan fits into the broader department strategic plans, where we have a section that is focused on EMS… the strategic plans are updated and planned for over several years and then re-evaluated at the end of that period. Where we have failed to reach a target or goal, we re-incorporate those projects into future plans"
	3.2	Relationships	"We form part of the (health) departments system as a whole and filter into the departments committees… for me the most important thing is the relationship we have with them. I would rather we have someone with an understanding of quality and quality systems and improve their understanding of EMS, than have someone from EMS and need to bring their understanding up to understand quality. But either way, for me the most important thing is still about the relationship we have with them"
	3.3		"We measure quality through response times targets, through the number of complaints, and from feedback from the facilities we take patients to. Their feedback about the interaction with our staff is very important to me."
	3.4	Attitude	"The attitude of the staff is very important to me, and that's one of the biggest improvements we have planned for… It will be very difficult, but we want to involve organized labour, and invite them to be a part of the process… here they determine success or failure and that's why I want to make sure they have buy-in to the process and provide feedback"
	3.5	Technology	"Having systems in place such as CAD systems will allow us to monitor everything involving staff, vehicles, how they are used, all of which will allow us to monitor our performance more closely and to make the sure the staff are held responsible and accountable, because this will also allow us to provide extra information to the public as a measure of our performance as well"
4. North West Director-level participant	4.1	Structure	"We're not a provincialized service, we're a totally decentralised service, each EMS station reports to the subdistrict they are in, so there's no provincial structure. Currently we are the only province that is like that… Basically we've got like 19 different EMS services in the North West."
	4.2	Staff capacity	"we lost a lot of them to OSD (occupational specific dispensation) …the OSD has shot us in the foot. We're losing a lot of staff because we can't retain them, so we're training, but we're actually training for [other services)"
	4.3	Non-personal resources	"I'm finding out from research that we don't need such a high amount of ambulances, we need to be focusing more on planned patient transport, because 65% of our calls are actually P3, so we're using a very expensive resource to transport something that we don't need to transport"
	4.4	Technology	"the unfortunate thing is all our stuff is paper-based, and we don't have a digital system. So, we are moving towards a digital communication system, but currently it's very easy to lie to your statistics, so I cannot trust the information given to me"
5. Private Service Senior manager-level participant	5.1	Leadership	"We're probably as good as a 5 as you can get, in my opinion. [Representatives] From the CEO, to the operational crews sit on a clinical committee, there's a quality assurance manager that sits at an executive level, and all of this works through, it's all auditable through minutes and committee meetings that report into the executive committee"
	5.2	Representation	"we've got representatives from cross the organisation sitting on the clinical panel to discuss what the consumer wants, what training needs to be provided, what operations is currently doing and where the operations within operations is needed"
	5.3	Improvement focus	"If we're doing a quality improvement project, if it gets written down as a quality improvement project, and not just an intervention, then we do put the assurances in place, putting in the checks to monitor it over and time and then look at whether there's a consistent change in behaviour or not"
	5.4	Fit for purpose	"our biggest problems in terms of this are systems. We often review stuff, and we often see, and we might know what quality indicators to use, but the problem comes in that the system we currently have is, manual, and very hard to change any kind of quality indicators, because it's an accounting system that we're using for quality indicators essentially, and it's still paper-based, and manually captured"
	5.5	Patient/community engagement	"In terms of a structured patient satisfaction assessment, we do have that. In terms of having a point of entry into the business for patients concerns to be brought up, we do have that, that's very well developed at [parent company]. I think the problem comes in when you start talking about patient or community engagement when it comes to patient centred events, and I don't think we're there yet."

EMS, emergency medical services.

Despite the low scores for *staff engagement* and *evaluation*, these had been areas earmarked for attention in the services current strategic plan. Staff attitude was acknowledged and planned for as an important driver of general service success (3.4). Similarly, technology was also earmarked as a driver of success, both for staff engagement, and community accountability as well (3.5).

North West

Population: 3 925 000 (6.8%).

No. of households: 1 210 000 (7.3%).

Public transport use: 41.3%.

The NW scored low across all questions and categories in the formative assessment. This was unsurprising considering (unbeknownst to the authors at the time of data collection) the provincial government, including the health system and EMS, had been placed under administration. On deeper examination, several key factors became apparent that highlighted the difficulties faced by EMS in the province.

From a managerial perspective, the extreme decentralisation in which the service was structured made coordination and oversight complicated, and significantly hindered process and/or plan implementation (4.1). Coupled with this, the service found it difficult to retain high-level clinical staff, further hampering the ability to implement and sustain a clinically focused quality programme (4.2). From an operations point of view, based on a recent audit, it was recognised that the province's non-personnel resources were inappropriately matched towards the needs of their daily activity (4.3, 4.4).

The QIs that were reported by the service were limited to time-based measures, and vehicle and staff counts. Furthermore, the service lacked their own standalone committees regarding complaints and patient safety, which were instead incorporated into broader general provincial health service committees and structures.

Private service

Based on the formative assessment and interview, several strengths were highlighted within the service, largely centred around *structur*e. There was a strong clinical focus within the quality system of the service, with representation up to the executive level (5.1). Furthermore, while input was collected from across the service branches, much of the planning came from a centralised office, providing overall strategic direction (5.2). Similarly, there was a relatively strong focus on quality improvement activities within the service. While input and scope were somewhat limited, a robust and comprehensive process was consistently followed when a project was carried out (5.3).

In contrast, the service acknowledged that there was room for improvement with regards to programme *planning* and *evaluation*. While a quality management plan existed, it was outdated, and not often reviewed, at least in any formal capacity. Likewise, while several clinically focused indicators are consistently reported and discussed at a high level, the system was acknowledged to be outdated and rudimentary, largely manually captured, and difficult to change as it is not fit for purpose (5.4). This was perceived to have had an impact on both general quality monitoring and monitoring for sustained improvement.

Of all the categories, staff and patient engagement were perceived to be the weakest, and an area for improvement within the service. The strengths the service enjoyed in this area were largely as a result of the services private hospital group parent company (5.5).

Secondary data

Nationally and provincially focused policy documents were included as part of the secondary data collection (table 4). Several concentrated on the development and implementation of quality and patient safety systems yet were almost exclusively limited to health facilities. Despite this, they were in depth and pragmatic in their approach towards outlining the steps required to implement effective quality systems. While these may not all be applicable to the EMS setting, several of the concepts outlined in these documents were considered useful towards the development of similar systems for EMS.

Of the EMS focused documents, all of these were limited to high-level/strategic 'statements' regarding quality or patient safety. None of the documents found reported any measures of clinical quality, with the focus solely restricted to call times and call volumes. Furthermore, no policy-related documents were found that outlined minimum standards or provided steps towards the development and/or implementation of a quality system or clinically focused QIs for EMS.

DISCUSSION

Healthcare organisational case studies have been identified as an important methodological approach towards describing the factors facilitating and impeding quality systems.[18] This was echoed in our study, where several broad observations were made regarding EMS quality systems in SA. From a system structure perspective, a centralised approach with appropriate and engaged senior/executive level management established responsibility of the system and facilitated greater control over the direction of the system, whereas decentralisation hampered collection and reporting, and as a consequence, accountability. Leadership has previously been identified as an essential component in health quality systems, a factor present in this study as both a driver of success when incorporated, and a barrier when inadequate or unaccounted for.[11 19–21] The lack of a cohesive vision and/or mission regarding quality, and the role of leadership towards developing and driving these concepts has also been associated with organisations who consistently struggle to improve quality and were similarly lacking or poorly developed within the services assessed in this study.[21]

Factors associated with infrastructure, support and capacity have too been identified as key drivers of success of quality systems in healthcare.[19–21] While structure was among the highest scored attributes of the participating service assessments, insufficient capacity was often identified as a weak link in this study. The combination of leadership and capacity has been described as primary drivers of a quality culture in healthcare quality systems; another component reported as both an enabler of high-quality

Table 4 Policy review

Region	Document	Publication date	Health facility focus	EMS focus	Supporting quote for EMS guidance	Ref
National	A Policy on Quality in Healthcare for South Africa	April 2007	Yes	No	Nil	12
	"Towards Quality Care for Patients" National Core Standards for Health Establishments in South Africa	2011	Yes	No	Nil	25
	South African Department of Health Strategic Plan 2015–2019	2014	Yes	Yes	**Strategic objectives:** ► Ensure the effective and efficient delivery of Emergency Medical Services ► Ensure access to effective and efficient delivery of quality Emergency Medical Services	26
	National Policy to Manage Complaints, Compliments and Suggestions in the Public Health Sector of South Africa	July 2016	Yes	No	Nil	27
	National Policy for Patient Safety Incident Reporting and Learning in the Public Health Sector of South Africa	July 2016	Yes	No	Nil	28
	National Health Act, 2003 (Act no. 61 of 2003) National Health Insurance Policy	2017	Yes	Yes	**Improving access to Emergency Medical Services:** 156. A uniform level of quality for Emergency Medical Services (EMS) and Facility-based Emergency Care will be provided across the country according to nationally determined norms and standards in relation to the level of care, staffing requirements, prescribed equipment, suitability of response vehicles and ambulances and other relevant components based on the level of care.	29
	National Health Act, 2003 (Act no. 61 of 2003) Emergency Medical Service Regulation	December 2017	No	Yes	**Consideration of application for Licence:** (c) the need to promote quality services which are accessible, affordable, cost-effective and safe; (h) where applicable, the quality of health services rendered by the applicant in the past; **Management of Emergency Medical Service:** (b) ensure that the Emergency Medical Service is operated in a way that provides quality care and does not compromise the safety of the public, patient or personnel; (t) ensure that there are mechanisms in place for the management of complaints, consultation, clinical governance and quality assurance	30
	Professional Board for Emergency Care Clinical Practice Guidelines	2018	No	Yes	**Important Additional notes** All interventions and medications are to be performed and administered within the Clinical Practice Guidelines and a locally relevant standard of care. Clinical governance structures shall support these guidelines	31

Continued

Table 4 Continued

Region	Document	Publication date	Health facility focus	EMS focus	Supporting quote for EMS guidance	Ref
Western Cape	Western Cape Ambulance Services Act, 2003	2003	No	Yes	**Norms, standards and quality assurance** 7. (1) The MEC shall prescribe minimum norms and standards for the delivery of ambulance services which will include— a. equitable access; b. the use of volunteers; c. personnel, vehicle and equipment requirements; d. communication and co-ordination procedures; and e. systems to receive, investigate and remedy complaints.	32
	Healthcare 2030	2014			**Emergency Medical Services:** ► EMS district managers will closely support district health managers by providing EMS-related data for monitoring and evaluation ► International benchmarking and best practice establish that EMS is best delivered as a provincial service rather than a local service.	33
	Western Cape Government Health Annual Report	2018	Yes	Yes	**Reported indicators:** ► EMS P1 urban response under 15 min rate ► EMS inter-facility transfer rate ► Total number of EMS emergency cases	34
KwaZulu Natal	KwaZulu Natal Department of Health Strategic Plan 2015–2019	2015	Yes	Yes	**Priority 2: Improve the Efficiency of Emergency Medical Services:** ► Governance structures will be strengthened, and training of managers will be prioritized to improve management and quality. ► Appropriate ICT infrastructure (including mobile data terminals) and computers will be installed at all ambulance bases to ensure access to on-line facilities to improve data accuracy and availability. ► An appropriate electronic patient booking system will be introduced to improve appropriate response to emergency calls.	35
	Quality improvement Intervention based on Patients Safety Incident (PSI)	2016	Yes	Nil	Nil	36
	KwaZulu Natal Department of Health Annual Report	2018	Yes	Yes	**Reported indicators:** ► Total number of EMS clients ► Total number of interfacility transfers ► Percentage of response times to red codes (P1) within 15 mins for urban areas ► Percentage of response times to red codes (P1) within 40 mins for rural areas ► Cases attended to by Air Ambulance Services ► Aeromedical Services utilisation per district ► Ambulances per 10 000 population	37

Continued

Table 4 Continued

Region	Document	Publication date	Health facility focus	EMS focus	Supporting quote for EMS guidance	Ref
North West Province	North West Department of Health Strategic Plan 2015–2019	2015	Yes	Yes	**Strategic Goal 2:** ► Improve the quality of care by setting and monitoring national norms and standards, improving systems for user feedback, increasing safety in health care, and by improving clinical governance.	38
	North West Department of Health Annual Report	2018	Yes	Yes	**Reported indicators:** ► EMS Operational ambulance coverage ► EMS P1 urban Response under 15 min rate ► EMS P1 rural Response under 40 min rate EMS interfacility Transfer rate	39
Limpopo	Limpopo Department of Health Annual Report	2018	Yes	Yes	**Reported indicators:** ► Ratio of ambulances per population ► Number of ambulances procured ► EMS P1 urban Response under 15 min rate ► EMS P1 rural Response under 40 min rate ► EMS inter-facility transfer rate	40

systems when present, and a barrier to its success when absent.[19–21] It is unsurprising that given the lack of each of these components in the participating services that culture did not feature as a common observation or discussion point within the assessment and interviews.

All participating services were limited in their measurement of either adverse events, technical quality of care or patient-reported measures, with the primary focus largely centred around time-based measures. This is in contrast to the increasing focus on non-time-based measures of quality evident in the literature.[22] This limitation was widely acknowledged and partially justified around the perceived purpose of EMS and what was understood to be the mandate of these services in SA. Non-time-based measures of safety and quality have previously been used as a strong base with which focused quality improvement programmes have led to meaningful and improved patient outcomes in the PEC setting. The lack of such measures could in part explain the generally poor results observed regarding quality improvement in this study.

Resources and technology were a common feature among the interviews as a potential driver for improvement in quality systems. Of interest to note, there was limited discussion regarding the perceived benefits offered by technology during the evaluation of the WC, as the only user of computer-aided dispatch system and electronic patient records. It nonetheless remained a specific solution identified by the remaining services as the answer to many of the problems they faced regarding quality. These contrasting views are evident in the literature, where the importance of technological resources has been often debated, and where a lack of consensus regarding their influence and status has them described as 'probationary' when it comes to their role in quality systems.[19 20]

There was little to no supporting documentation in the way of national policies and/or guidelines for EMS in either implementing quality systems, measuring quality or reporting performance. Furthermore, there was a general lack of policy outlining minimum standards for EMS quality systems altogether. This was evident in the variation of the results of the quality programme assessment and further highlights the need for such guidance. To be effective in both implementation and use, it is essential that appropriate high-level guidance and minimum standards regarding quality systems be outlined, as a driver for change.[23 24]

In order to deliver safe, high-quality care, it is crucial that the system or mechanism responsible for monitoring and maintaining this process is equally efficient and effective in doing so. Understanding the factors affecting this process are essential towards identifying areas and priorities for improvement within the system. The outcomes of this study have provided a base from which the factors affecting quality systems in EMS in SA can be addressed. However, as systems evolve and mature in their approach towards quality and safety, so will the factors that affect the success of the system. As such, quality system evaluation should become a regular, scheduled component of the system itself. Towards this, our study has described one approach that can be used as an objective, repeatable measure of quality system development.

Limitations

The nature of the questions which case study research in general—and this article in particular—attempt to

answer limit the overall extent to which the results are generalisable and/or reproducible. We attempted to address this through the previously described approach towards enhancing the validity and trustworthiness of the methodology. Despite this, the results of this study need to be understood within the context in which they were studied and appreciate the impact this has on the observations and their broader potential implications. While the specific observations found in this study may not be generalisable, the outcomes are nonetheless consistent with what is known in the literature.

CONCLUSION

A multitude of factors were identified that affected the effectiveness of quality systems, centred around leadership, vision and mission, and quality system infrastructure and capacity, guided by the need for comprehensive yet pragmatic strategic policies and standards. Understanding and accounting for these factors will be key to ensuring both successful implementation and ongoing utilisation of healthcare quality systems in PEC in SA. The result will not only provide a more efficient and effective service, but also positively impact patient safety and quality of care of the services delivered.

Author affiliations
[1]Department of Clinical Science and Education, Karolinska Institutet, Stockholm, Sweden
[2]Division of Emergency Medicine, Stellenbosch University, Stellenbosch, Western Cape, South Africa
[3]Public Health and Preventive Medicine, Monash University, Melbourne, Victoria, Australia
[4]Division of Emergency Medicine, University of Cape Town, Rondebosch, Western Cape, South Africa
[5]Department of Emergency Medicine and Services, Helsinki University, Helsinki, Finland
[6]Department of Neurobiology, Care Sciences and Society, Karolinska Institute, Stockholm, Sweden

Acknowledgements The authors would like to thank Raveen Naidoo for facilitating the assessments and interviews for data collection.

Contributors All authors conceived the study. IH conducted the data collection and analysis and takes responsibility for the paper. IH drafted the manuscript, and all authors contributed substantially to its revision.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not required.

Ethics approval Stellenbosch University Health Research Ethics Committee (Ref no. S15/09/193).

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data are available upon reasonable request.

REFERENCES

1 Hesselink G, Berben S, Beune T, *et al*. Improving the governance of patient safety in emergency care: a systematic review of interventions. *BMJ Open* 2016;6:1–12.
2 Redlener M, Olivieri P, Loo GT, *et al*. National assessment of quality programs in emergency medical services. *Prehospital Emergency Care* 2018;22:370–8 https://doi.org/
3 Stang AS, Wingert AS, Hartling L, *et al*. Adverse events related to emergency department care: a systematic review. *PLoS One* 2013;8:e74214.
4 Howard IL, Bowen JM, Al Shaikh LAH, *et al*. Development of a trigger tool to identify adverse events and harm in emergency medical services. *Emerg Med J* 2017;34:391–7.
5 Patterson PD, Lave JR, Martin-Gill C, *et al*. Measuring adverse events in helicopter emergency medical services: establishing content validity. *Prehosp Emerg Care* 2014;18:35-45.
6 Howard I, Pillay B, Castle N, *et al*. Application of the emergency medical services trigger tool to measure adverse events in prehospital emergency care: a time series analysis. *BMC Emerg Med* 2018;18.
7 Howard I, Cameron P, Wallis L, *et al*. Identifying quality indicators for prehospital emergency care services in the low to middle income setting: the South African perspective. *Afr J Emerg Med* 2019;9:185-192.
8 Broccoli MC, Moresky R, Dixon J, *et al*. Defining quality indicators for emergency care delivery: findings of an expert consensus process by emergency care practitioners in Africa. *BMJ Global Health* 2018;3:e000479 http://gh.bmj.com/lookup/doi/
9 Wardhani V, Utarini A, van Dijk JP, *et al*. Determinants of quality management systems implementation in hospitals. *Health Policy* 2009;89:239–51.
10 MacFarlane C, van Loggerenberg C, Kloeck W. International EMS systems in South Africa--past, present, and future. *Resuscitation* 2005;64:145–8.
11 Howard I, Cameron P, Castrén M, *et al*. Knowledge, attitude and practices of clinical quality and performance assessment among emergency medical services personnel in South Africa: a mixed methods study. *Emerg Med Australas* 2019;31:1024–36.
12 Department of Health. A policy on quality in health care for South Africa. *Dep Heal Repub South Africa* 2007.
13 Hatch AJ. Deciding to do a qualitative study. *Doing Qual Res Educ Settings* 2002;11:1–20.
14 Yin R. *Case study research and applications: design and methods*. 6th edn. California: SAGE Publications, 2018.
15 Hsieh H-F, Shannon SE. Three approaches to qualitative content analysis. *Qual Health Res* 2005;15:1277–88.
16 Bowen GA. Document analysis as a qualitative research method. *Qual Res J* 2009;9:27–40.
17 Guba EG. Criteria for assessing the trustworthiness of naturalistic inquiries. *Educ Commun Technol* 1981;29:75–91.
18 Baker GR. The contribution of case study research to knowledge of how to improve quality of care. *BMJ Qual Saf* 2011;20:i30–5.
19 Øvretveit J. Understanding the conditions for improvement: research to discover which context influences affect improvement success. *BMJ Qual Saf* 2011;20:i18–23.
20 Kaplan HC, Provost LP, Froehle CM, *et al*. The model for understanding success in quality (MUSIQ): building a theory of context in healthcare quality improvement. *BMJ Qual Saf* 2012;21:13–20.
21 Vaughn VM, Saint S, Krein SL, *et al*. Characteristics of healthcare organisations struggling to improve quality: results from a systematic review of qualitative studies. *BMJ Qual Saf* 2019;28:74–84.
22 Howard I, Cameron P, Wallis L, *et al*. Quality indicators for evaluating prehospital emergency care: a scoping review. *Prehosp Disaster Med* 2018;33:43–52.
23 Harteloh PPM. The meaning of quality in health care: a conceptual analysis. *Health Care Analysis* 2003;11:259–67 http://www.ncbi.nlm.nih.gov/pubmed/14708937
24 Harteloh PPM. Quality systems in health care: a sociotechnical approach. *Health Policy* 2003;64:391–8.
25 National Department of Health. National core standards for health establishments in South Africa 1–16, 2011. Available: http://www.phango.org.za/component/docman/cat_view/45-general%5Cnwww.doh.gov.za
26 South African National Department of Health. Republic of South Africa department of health strategic plan 2014-2019, 2018. Available: https://www.health-e.org.za/wp-content/uploads/2014/08/SA-DoH-Strategic-Plan-2014-to-2019.pdf
27 National Department of Health. National policy to manage complaints, Compliments and suggestions in the public health sector of South Africa, 2016. Available: http://www.samed.org.

za/Filemanager/userfiles/National Policy to Manage Complaints Compliments and Suggestions 7 July 2016x (2).pdf
28 National Department of Health. National Policy for Patient Safety Incident Reporting and Learning in the Public Health Sector of South Africa [Internet], 2016. Available: http://www.who.int/patientsafety/en/brochure_final.pdf%0Ahttp://www.ncbi.nlm.nih.gov/books/NBK43621/%0Ahttp://dx.doi.org/10.1016/j.ergon.2011.08.004%0Ahttp://search.proquest.com/docview/1732805751?accountid=14477%5Cnhttps://nevada.ual.es/biblioteca/gtb/so
29 Department of Health South Africa. National health insurance policy 1–67, 2017. Available: :///C:/Users/Emily M/Downloads/white paper - nhi - 2017 (1).pdf
30 National Department of Health. Emergency medical services Regualtions. Gov Gaz no 41287, 2017. Available: http://us-cdn.creamermedia.co.za/assets/articles/attachments/72257_41287_gon1320.pdf
31 Professional Board for Emergency Care. South African emergency medical services clinical practice guidelines 2018.
32 Western Cape Department of Health. Western Cape ambulance services act 2003.
33 Western Cape Government. Healthcare 2030. 2014:1–160.
34 Western Cape Department of Health. Western Cape Government,Department of Health Annual Report 2017.
35 KZN Department of Health. Strategic plan 2014.
36 KZN Department of Health. Quality improvement intervention based on patients safety incident 2015.
37 Department of Health KZN. 2017 / 18 annual report. *Annu Rep* 2018:1–417.
38 North West Department of Health. North West Province five year strategic plan 2015:106.
39 North West Department of Health. Annual report 2018.
40 Limpopo Department of Health. Annual report. Annu. Rep. 2017/18 Financ. year 2018.

ORIGINAL RESEARCH

Quality Indicators for Evaluating Prehospital Emergency Care: A Scoping Review

Ian Howard, BEMC, MPhil;[1,2] Peter Cameron, MD, FACEM;[3] Lee Wallis, MBChB, FRCEM;[2] Maaret Castren, MD, PhD;[4] Veronica Lindstrom, RN, PhD[1,5]

1. Department of Clinical Science and Education, Södersjukhuset, Karolinska Institutet, Stockholm, Sweden
2. Division of Emergency Medicine, Stellenbosch University, Stellenbosch, South Africa
3. School of Public Health and Preventive Medicine, Monash University, Melbourne, Australia
4. Department of Emergency Medicine and Services, Helsinki University Hospital, Helsinki University, Helsinki, Finland
5. Academic EMS, Stockholm, Sweden

Correspondence:
Ian Howard, BEMC, MPhil
Department of Clinical Science and Education, Södersjukhuset
Karolinska Institutet Stockholm, Sweden
E-mail: ianhoward@outlook.com

Conflicts of interest: none

Keywords: Emergency Medical Services; health care quality assessment; patient safety; quality indicators

Abbreviations:
EMS: Emergency Medical Services
PEC: prehospital emergency care
QI: quality indicators

Received: December 1, 2016
Revised: February 19, 2017
Accepted: April 1, 2017

doi:10.1017/S1049023X17007014

Abstract

Introduction: Historically, the quality and performance of prehospital emergency care (PEC) has been assessed largely based on surrogate, non-clinical endpoints such as response time intervals or other crude measures of care (eg, stakeholder satisfaction). However, advances in Emergency Medical Services (EMS) systems and services worldwide have seen their scope and reach continue to expand. This has dictated that novel measures of performance be implemented to compliment this growth. Significant progress has been made in this area, largely in the form of the development of evidence-informed quality indicators (QIs) of PEC.

Problem: Quality indicators represent an increasingly popular component of health care quality and performance measurement. However, little is known about the development of QIs in the PEC environment. The purpose of this study was to assess the development and characteristics of PEC-specific QIs in the literature.

Methods: A scoping review was conducted through a search of PubMed (National Center for Biotechnology Information, National Institutes of Health; Bethesda, Maryland USA); EMBase (Elsevier; Amsterdam, Netherlands); CINAHL (EBSCO Information Services; Ipswich, Massachusetts USA); Web of Science (Thomson Reuters; New York, New York USA); and the Cochrane Library (The Cochrane Collaboration; Oxford, United Kingdom). To increase the sensitivity of the literature, a search of the grey literature and review of select websites was additionally conducted. Articles were selected that proposed at least one PEC QI and whose aim was to discuss, analyze, or promote quality measurement in the PEC environment.

Results: The majority of research (n = 25 articles) was published within the last decade (68.0%) and largely originated within the USA (68.0%). Delphi and observational methodologies were the most commonly employed for QI development (28.0%). A total of 331 QIs were identified via the article review, with an additional 15 QIs identified via the website review. Of all, 42.8% were categorized as primarily *Clinical*, with *Out-of-Hospital Cardiac Arrest* contributing the highest number within this domain (30.4%). Of the QIs categorized as *Non-Clinical* (57.2%), *Time-Based Intervals* contributed the greatest number (28.8%). *Population on Whom the Data Collection was Constructed* made up the most commonly reported QI component (79.8%), followed by a *Descriptive Statement* (63.6%). Least reported were *Timing of Data Collection* (12.1%) and *Timing of Reporting* (12.1%). Pilot testing of the QIs was reported on 34.7% of QIs identified in the review.

Conclusion: Overall, there is considerable interest in the understanding and development of PEC quality measurement. However, closer attention to the details and reporting of QIs is required for research of this type to be more easily extrapolated and generalized.

Howard I, Cameron P, Wallis L, Castren M, Lindstrom V. Quality indicators for evaluating prehospital emergency care: a scoping review.

Introduction

Internationally, the primary function of the Emergency Medical Services (EMS) is the timely and safe delivery of the sick or injured to definitive care. Historically, performance of these services, and the quality of prehospital emergency care (PEC) delivered, has been assessed largely based on surrogate, non-clinical endpoints such as response time intervals or other crude measures of care (eg, stakeholder satisfaction).[1-3]

Given that such measures are relatively simple, quantifiable, and readily understood by both the lay public and policy makers, they became the predominant indicators of EMS quality and performance.[2,4,5]

However, there is a growing body of evidence to suggest that adhering to such measures has been reported to offer limited benefits, may only be applicable in select patients, and are insufficient alone to gauge the quality of care provided by EMS.[6-10] In addition, advances in EMS systems and services world-wide have seen their scope and reach continue to expand.[11-14] This historical approach towards quality assessment, in conjunction with the recent growth and development within the industry, has dictated that these services take greater accountability for their performance and the quality of care they deliver.

Over the last two decades, significant progress has been made in this area, largely in the form of the development of evidence-informed quality indicators (QIs) of PEC.[2,15-18] Quality indicators represent one aspect of health care quality measurement that are designed to measure "the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge."[19] Quality indicators have the advantage of not only documenting quality of care, but they assist in benchmarking quality and performance, they guide priorities for improvement initiatives, and they support overall accountability and transparency within health care.[19]

The ideal QI is one that is meaningful, scientifically sound, generalizable, and easily interpreted.[20] Despite the existence of relatively robust and comprehensive recommendations in the literature guiding the development of health care QIs, the process can be an inherently complex task, which in order to accomplish, must be designed and implemented with scientific rigor.[19-22] This is of particular importance when considering the underlying frameworks and data components necessary for their creation.[19-22] These components not only ensure that the QIs are appropriately implemented and utilized, but they also aid in reducing subjectivity in their application and interpretation as well.

Little is known about the development of QIs specific to the PEC environment, despite the recent progress reported. The purpose of this study was to assess the characteristics of development and data attributes of PEC-specific QIs in the literature.

Methods

A scoping review was conducted for the period up to April 2016 to identify peer-reviewed literature that examined QIs in the PEC environment. The scoping review methodology was selected given its primary aim to "map" the extent, range, and nature of a particular topic, summarizing the scope of evidence in order to convey the breadth and depth of a particular field.[23,24] This methodology is of particular use in new and emerging disciplines, where the quality of evidence and methodologies applied in previous research is unknown or varied.[23,24]

Search Strategy

Articles were identified by searching the following databases: PubMed (National Center for Biotechnology Information, National Institutes of Health; Bethesda, Maryland USA); Embase (Elsevier; Amsterdam, Netherlands); Cumulative Index to Nursing and Allied Health Literature (CINAHL; EBSCO Information Services; Ipswich, Massachusetts USA); Web of Science (Thomson Reuters; New York, New York USA); and the Cochrane Library (The Cochrane Collaboration; Oxford, United Kingdom). All searches were performed with no restrictions in terms of publication type or journal subset, date of publication, or patient age. Where applicable, searches were limited to English language articles and to research involving human subjects only.

Combinations and truncated variations of the following search terms were used for each database search: *Emergency Medical Service*, *prehospital emergency care*, *ambulance service*, *quality indicator*, *quality measure*, *performance measure*, *and performance indicator*. Relevant wildcards were used to account for singular and plural forms of each of the search terms. Variations in spelling were additionally used in varying combinations to broaden the search.

To increase the sensitivity of the search strategy, the OpenGrey (Institut de l'Information Scientifique et Technique; Vandoeuvre-lès-Nancy Cedex, France) repository of grey literature (ie, unpublished academic literature) was searched using the above-mentioned terms. In addition, the list of references of all included articles were manually searched for any potential articles meeting inclusion criteria. Lastly, the websites of the National Quality Forum (Washington, DC USA),[25] the Agency for Healthcare Research and Quality (Rockville, Maryland USA),[26] and the National Quality Measures Clearinghouse (Rockville, Maryland USA)[27] were manually searched for PEC-specific QIs.

Inclusion Criteria

For the purpose of this study, a QI was defined as: any measure that compared actual care against ideal criteria; or a tool used to help assess quality and/or performance. The threshold for inclusion was purposely kept low, and the following minimum criteria were utilized when identifying studies for further analysis:

- The aim of the research was to discuss, analyze, or promote quality measurement in the PEC environment;
- Research that proposed at least one prehospital QI of care or performance; and
- All peer-reviewed literature meeting inclusion criteria published prior to April 2016.

Exclusion Criteria

Non-English research, studies that examined disaster management/major incident response QIs, or research aimed at inter-facility transport measures of care were excluded. Furthermore, secondary research that examined QIs developed as part of a primary study already included in the analysis was excluded.

Article Review

Eligible articles were identified and analyzed in two parts. Firstly, the results of the database search were reviewed by title and abstract for potential inclusion, using the above-mentioned definitions and criteria (IH and VL). Disagreements between the two assessors were discussed, and if agreement could not be reached, the article was retained for further review. For the second part, the full-text articles remaining after the title and

abstract review were independently reviewed for satisfaction of the definitions and minimum inclusion criteria, and data were extracted utilizing a standardized data extraction form (Microsoft Excel 2010; Redwood, Washington USA; IH and VL). There was a high-level of agreement between raters for the inclusion of full-text articles for data extraction (Kappa statistic = 0.941). All disagreements in full-text article review and data extraction were resolved by consensus with no need for resolution by a third reviewer.

Article characteristics extracted included: type of research/methodology, country of origin, year of publication, institutional academic status, source of funding, population/age demographic studied, and description of the QIs within a broader organizational quality framework or structure. While seemingly abstract, for the purposes of this study, the latter component was defined as demonstration of how and/or where the QIs developed in the article reviewed aligned within a larger measurement or assessment structure in the PEC environment.

Quality indicator characteristics extracted included: origin of the QI, data source for developing the QI, definition of the QI data components, and whether or not a pilot of the QI was reported. In addition, the QIs found were categorized by the authors into one of two domains: *Clinical* or *Non-Clinical*. The criteria for QIs categorized into the *Clinical* domain were: those that assessed a specific intervention, or were dependent on the presence/absence of a disease or injury characteristic (eg, vital signs, symptoms, or treatment administered). Quality indicators categorized into the *Non-Clinical* domain were defined as those that primarily focused on an aspect of service delivery (eg, communication or documentation). Within each domain, the QIs were further divided by sub-domain (ie, clinical pathway for *Clinical* QIs; or by area of service for those QIs categorized as *Non-Clinical)*.

Lastly, if not identified as such within the article, each QI was additionally classified according to Donabedian's quality assessment classification framework.[28] Donabedian's model conceptualizes quality of care and performance into one of three primary dimensions: *Structure*-, *Process*-, or *Outcome*-based indicators of quality.[28] *Structure*-based QIs were defined as those that examined the attributes of the setting in which health care occurs, and primarily included material resources (eg, facilities, equipment, and financing), human resources, and organizational structure. *Process*-based QIs were defined as those that outline the steps in the process of health care (ie, what the health care provider does to maintain or improve health; eg, making a diagnosis or recommending/implementing treatment). Lastly, *Outcome*-based QIs were identified as those that described the effects or impact of care on the health status of patients and/or populations (ie, changes in a patient's health status that could be attributed to antecedent care).[19-22,28] Article and QI characteristics were summarized as counts and proportions using Microsoft Excel 2010.

Results

The literature search identified a total of 1,843 potential articles for review (Figure 1). Following the title and abstract review, 1,754 articles did not meet inclusion criteria and were excluded, leaving 89 articles for full-text review. An additional 14 articles were included following a review of the list of references of the 89 articles identified. Following the removal of duplicate texts, 25 articles remained for the full-text review. The manual review of

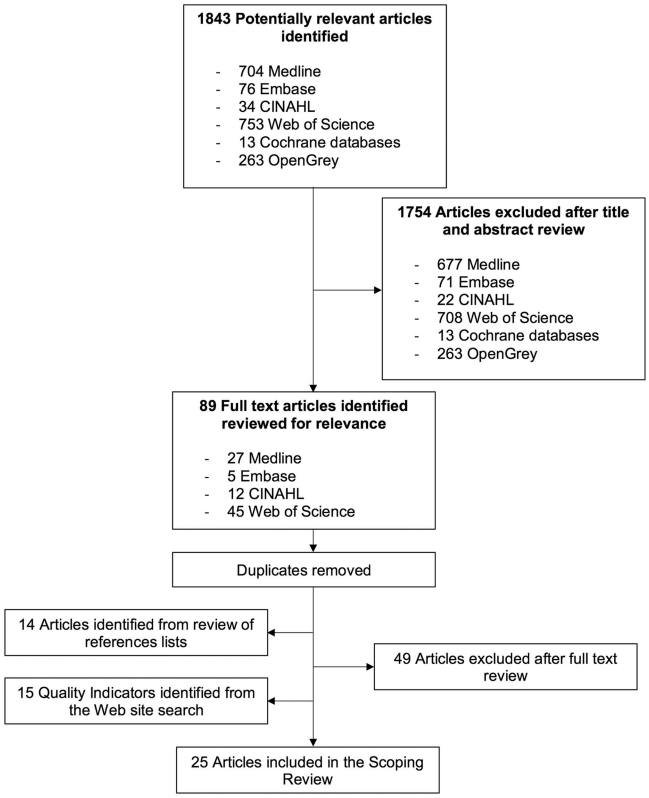


Figure 1. Selection of Articles for Review.

the OpenGrey repository revealed no applicable QIs for inclusion. Fifteen QIs were identified via a search of the National Quality Forum, the Agency for Healthcare Research and Quality, and the National Quality Measures Clearinghouse websites.

Description of Articles

The most common type of methodology employed in the development of the article-based QIs was split between a Delphi/RAND/Consensus type methodology (n = 7; 28.0%) and Observational Cohort study methodology (n = 7; 28.0%; Table 1). The majority of research was published within the last decade (n = 17; 68.0%) and largely originated within the USA (n = 17; 68.0%). All articles identified for the full-text review originated from countries identified as "developed" or "high-income." For just over one-half of the articles (n = 13; 52.0%), the academic status of the corresponding institution was that of a University or Higher-Learning Institute, followed by a mixture of both teaching (ie, University/Higher Learning) and non-teaching institutions (n = 9; 36.0%). Eight (32.0%) of the articles identified declared some form of government funding, followed by grants from private foundations (n = 5; 20.0%). Nine (36.0%) of the articles did not declare their source of funding. Discussion of the QIs developed, within the context of a broader organizational quality framework or structure, was found to occur in relatively few articles under review (n = 7; 28.0%).

Description of QIs

A total of 331 QIs were identified via the article review, with a median of 13 QIs per article (inter-quartile range 4.5-21),

Total Number of Articles	25 (%)
Type of Research	
Case Series/Case Audit	3 (12)
Delphi/Consensus Agreement	7 (28)
Literature Review/Systematic Review	5 (20)
Not Reported	1 (4)
Observational Cohort Study	7 (28)
RAND/UCLA Appropriateness Method	2 (8)
Country of Origin	
United Kingdom	3 (12)
USA	17 (68)
Australia	2 (8)
Canada	1 (4)
Israel	1 (4)
Netherlands	1 (4)
Year of Publication	
1985 - 1994	4 (16)
1995 - 2004	4 (16)
2005 - 2015	17 (68)
Institutional Academic Status	
Non-Teaching	3 (12)
University	13 (52)
Mixed	9 (36)
Source of Funding	
Government	8 (32)
Private Foundation	5 (20)
Mixed	3 (12)
Not Reported	9 (36)
Population/Age Demographic	
Adult	7 (28)
Pediatric	3 (12)
Mixed Adult & Pediatric	1 (4)

Table 1. Article Characteristics [a,b]

[a] Excludes web-based indicators.

[b] Categories not mutually exclusive.

and a range of one to 29 QIs per article. In addition, 15 QIs were identified via the website review, for a total of 346 QIs. The article authors were cited as the most common origin or source for the development of QIs found (n = 260; 75.1%). One hundred and fifty-two QIs (43.9%) were developed with the involvement of a local health care provider group, and 80 (23.1%) received input from a national or international organization or body (Table 2). Just under one-third of the QIs identified in the article review were of mixed origin (n = 105; 30.6%) in their development. The most common reported data source utilized was a survey/questionnaire (n = 172; 49.7%) or medical record review (n = 80; 23.1%). Over one-third of the QIs reviewed (n = 126; 36.4%) did not have a reported data source for their development or otherwise could not be explicitly determined.

Nine specific data components of the reported QIs were assessed in an attempt to provide insight into their development. The *Population on Whom the Data Collection was Constructed* made up the most commonly reported component (n = 276; 79.8%), followed by a *Descriptive Statement* for the QI in question (n = 220; 63.6%). The least reported components were those of *Timing of Data Collection*, reported for 42 QIs (12.1%), and *Timing of Reporting* (n = 42; 12.1%). Pilot testing of the QIs was reported on 120 (34.7%) of the QIs identified in the review.

Of the 346 QIs identified, 148 (42.8%) were categorized as primarily *Clinical*. Figure 2 summarizes the further categorization of the C*linical* domain QIs by sub-domain. *Out-of-Hospital Cardiac Arrest* contributed the highest number within this domain (n = 45; 30.4%), followed by the *Non-Traumatic Chest Pain/Acute Coronary Syndrome* sub-domain (n = 30; 20.3%) and the *General* sub-domain, made up of largely intervention or medication-based QIs (n = 26; 17.6%). Figure 3 summarizes the categorization of the *Non-Clinical* domain (n = 198; 57.2%). The *Non-Clinical* QIs were further categorized into the basic area of service within the PEC environment they affected. *Time-Based Intervals* contributed the greatest number (n = 57; 28.8%), followed by *Resource Deployment* (n = 34; 17.2%) and the *Adverse Event Detection/Classification* sub-domain (n = 17; 9.0%). Table 3,[18,29-46] and Table 4,[30,33-38,43-53] illustrate a breakdown of the *Clinical* and *Non-Clinical* domain QIs by source article. Donabedian's quality assessment classification framework was the only such system employed for the classification of the reported QIs, and it was utilized in three (12%) of the articles reviewed. Thirty-nine of the article QIs and all 15 QIs found via the website review were classified according to this system (15.6%). The remaining 292 QIs were assigned a classification by the authors as part of the review, using Donabedian's framework. Process measures made up the largest groups of both the reported and assigned classifications (Reported n = 31, 9.0%; Assigned n = 194, 66.4%). Table 2 highlights the division of the reported and assigned classifications for each QI.

It was the intention of the authors to attempt to assess the quality of evidence presented in each article under review a-priori; however, given the use of consensus-based methodologies in the majority of the articles assessed, in conjunction with little to no discussion of the underlying evidence base within each of the articles, this evaluation was abandoned.

Discussion

This scoping review revealed a substantial body of literature regarding QIs specific to PEC. It is apparent that there is rising

Total Quality Indicators (QIs)	346 (%)
Article-Based QIs	331 (95.7)
Web-Based QIs	15 (4.3)
Origin of QI	
Article Authors	260 (75.1)
Single Origin Source	240 (69.4)
Mixed Origin Source	106 (30.6)
Local Health Care Provider Group Input	152 (43.9)
National/International Organization Input	80 (23.1)
Data Source for Developing QI	
Direct Observation	26 (7.5)
Record Review	80 (23.1)
Registry	16 (4.6)
Survey/Questionnaire	172 (49.7)
Not Reported	52 (15.0)
Other	74 (21.4)
Definition of Components	
Descriptive Statement	220 (63.6)
List of Data Elements	89 (25.7)
Specifications for Data Collection	112 (32.4)
Population on Whom Data Collection is Constructed	276 (79.8)
Timing of Data Collection	42 (12.1)
Format Results will be Presented	57 (16.5)
Timing of Reporting	42 (12.1)
Measure Evaluation	49 (14.2)
Pilot of Indicator	
Yes	120 (34.7)
No	226 (65.3)
Clinical Domain	**148 (42.8)**
Non-Clinical Domain	**198 (57.2)**
Clinical Sub-Domain	
Airway Management	6 (4.1)
Asthma/Airway Obstruction	12 (8.1)
Non-Traumatic Chest Pain/Acute Coronary Syndrome	30 (20.3)
General/Interventions/Medications	26 (17.6)
Out-of-Hospital Cardiac Arrest	45 (30.4)
Seizures	2 (1.4)
Stroke	11 (7.4)
Trauma	13 (8.8)
Hypoglycemia	3 (2.0)
Non-Clinical Sub-Domain	
Adverse Events	22 (11.1)
Communications/Dispatch	9 (4.5)
Documentation	16 (8.1)
Employee Focused	8 (4.0)
Financial	6 (3.0)
Performance Monitoring/Audit/Appraisal	10 (5.1)
Receiving Facility Interaction	11 (5.6)
Research	1 (0.5)
Resources/Deployment	34 (17.2)
Service User Satisfaction	8 (4.0)
Time Intervals	57 (28.8)
Triage	16 (8.1)
Reported QI Classification	
Structure	8 (2.3)
Process	31 (9)
Outcome	15 (4.3)
No Reported Classification	292 (84.4)
Assigned QI Classification	
Structure	63 (21.6)
Process	194 (66.4)
Outcome	35 (24)

Table 2. Quality Indicator Characteristics [a] *(continued)*

Table 2 *(continued)*. Quality Indicator Characteristics [a]

Abbreviation: QI, quality indicator.

[a] Categories not mutually exclusive.

interest and understanding about the importance of quality measurement within PEC, evident by the increasing number of publications in recent years involving these concepts. This drive appears to be largely led by the academic community, with the involvement of non-teaching/non-higher learning institutions found to be relatively scarce, or at least their contribution under-reported. Given that quality measurement and improvement require a largely pragmatic approach, it is essential that closer collaboration between academic institutions and EMS

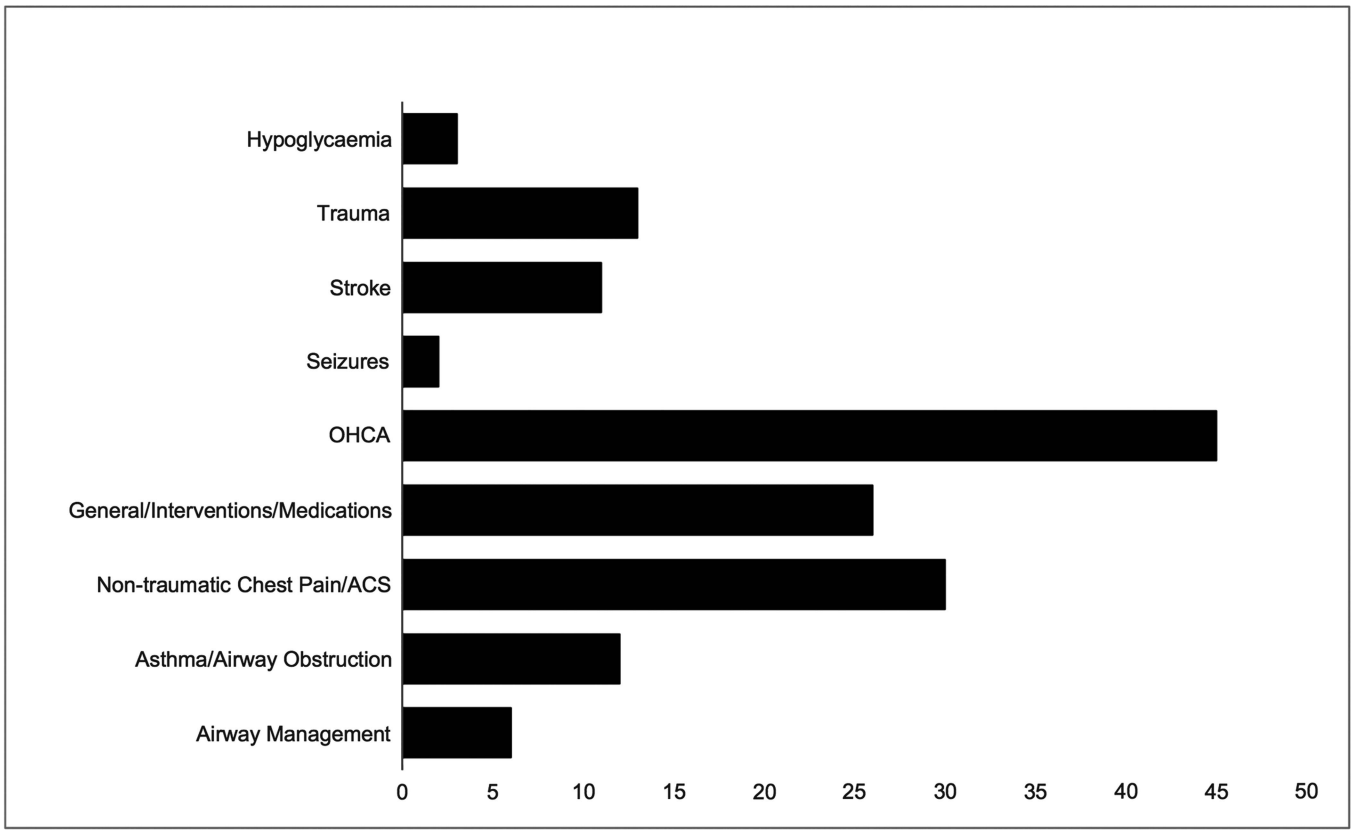


Figure 2. Distribution of Clinical Domain Quality Indicators (n = 148).

organizations occurs to improve the development of QIs for the PEC environment.

Similarly, there was an apparent lack of involvement of large national and international emergency care societies, committees, or networks in the development of the QIs identified by this review. Involvement of such bodies could potentially bring significant benefits for research in this area.

All of the research identified in this review originated in "high-income" or "developed" settings, with over one-half produced in North America, most notably the USA, followed by the United Kingdom and Australia. With the exception of one study originating in the Netherlands, there was an absence of research regarding PEC quality measurement from the remainder of Europe. It is interesting to note, however, that EMS models employed across these regions vary significantly. The North American approach utilizes emergency medical technicians as frontline staff and relies largely on medical control with physician oversight for its governance.[54] This aligns somewhat with the British and Australian approach where non-physician practitioners (paramedics) are employed under independent licensure.[55] In contrast, the Franco-German model utilizes physicians as frontline staff, whereas in Northern Europe, specialist PEC nurses are responsible for delivering PEC.[56,57] It is, however, impossible to determine any correlation between these two factors, and in addition, could potentially be explained through the limitation in search criteria to English language studies only.

Overall, the categorization of QIs was weighted towards what could be best described as *Non-Clinical* measures of quality. While these undeniably have an important part to play, one could argue that the legacy of surrogate measures such as response time targets continue to exert an influence in measuring quality within PEC, especially considering that *Time-Based* QIs made up the largest sub-domain amongst the *Non-Clinical* domain in this review. Within the *Clinical* domain, *Out-of-Hospital Cardiac Arrest* and *Non-Traumatic Chest Pain/Acute Coronary Syndrome*-based QIs contributed the largest number of QIs within this category. This is unsurprising given the known impact of PEC on outcomes for these patients.

Process-defined QIs were the most common classification reported in this review, followed by *Structure*-based indicators, when the QIs assigned a classification by the authors were taken into account. Patient outcomes and adverse events occurring in this time frame are inherently difficult to report in PEC, given the short duration of care in which these patients are exposed to EMS. As such, PEC quality assessment lends itself to evaluation by care processes and could account for this group contributing the largest classification type. The relative simplicity of *Structure*-based indicators, in both their implementation and interpretation, combined with the above-mentioned potential historical influence of time-based measures, could account for the large number of this group as well.

The description of the component parts for the QIs identified in this review was severely lacking, despite established recommendations guiding development.[19-22] These elements are as important as the QI itself, as they not only provide guidance and information for other researchers on the feasibility of implementation of the QI, but also on their utilization and analysis as well.[58-61] Similarly, it was apparent from this analysis that there is

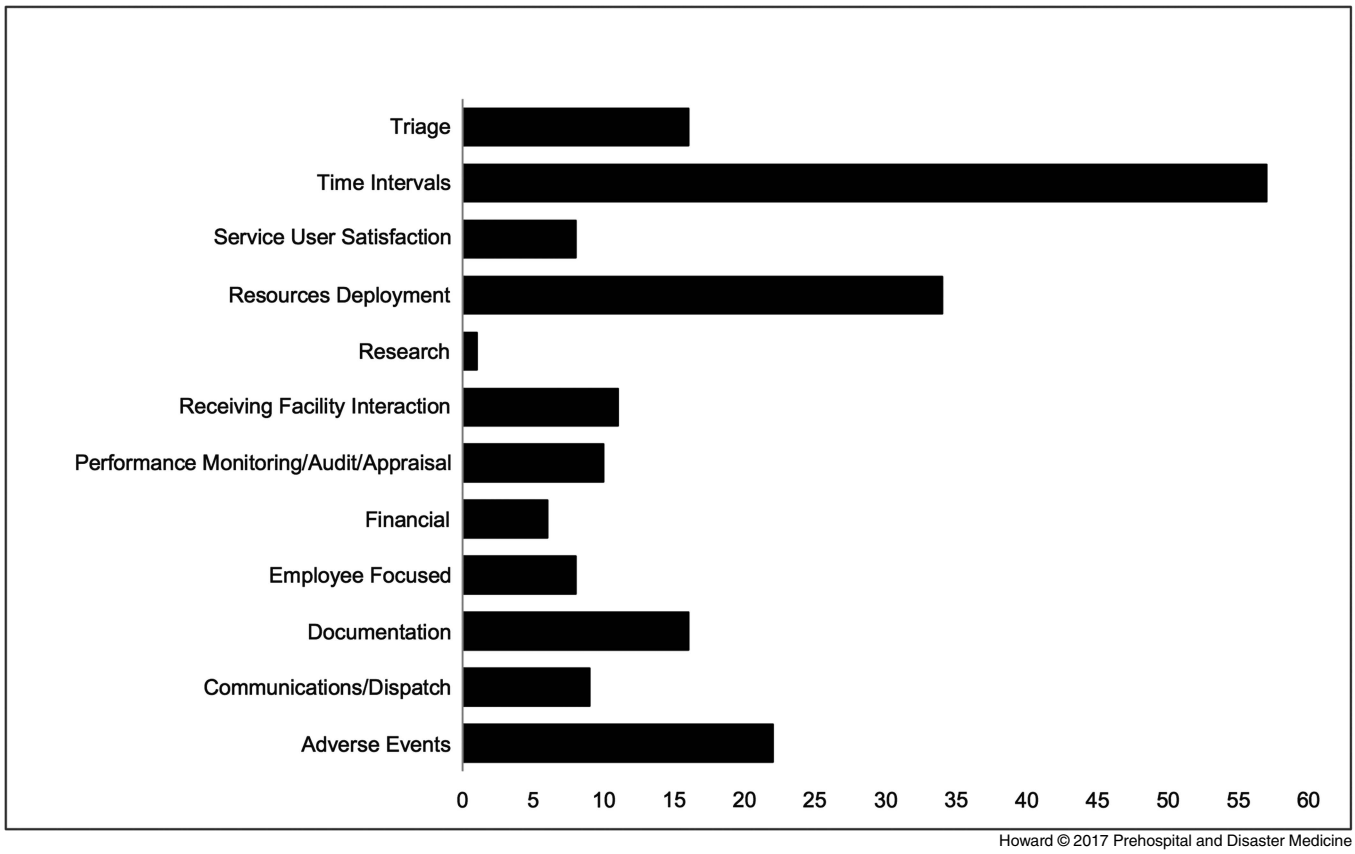


Figure 3. Distribution of Non-Clinical Domain Quality Indicators (n = 198).

insufficient consideration of PEC QIs within the broader organizational quality frameworks. The success of any form of quality measurement, be it through QIs, direct observation, trigger tools, or mortality reviews, is limited by the strength and rigor of the system in which it operates, and the ability of the system to ensure completion of the quality improvement process. Consideration of the importance that a quality framework adds towards the implementation of individual QIs is essential. When combined with other strategies of quality measurement, this not only ensures their appropriate use, but also affirms their relation to the final experience and outcome of a patient encounter with the health sector. One need only examine the development of response times as the sole historical measure of PEC quality as a prime example of poor QI implementation.

Limitations

The scoping review methodology has numerous advantages, many of which lie with the simplicity of its aim. However, this simplicity is not without its limitations. There is no established approach towards assessing the quality of research or evidence under review, such as that found with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines or Grading of Recommendations Assessment, Development, and Evaluation (GRADE) guidelines. Similarly, there is no system of assessing homogeneity of evidence or method of data synthesis.

The search criteria to identify potential articles for review was limited to English-language research only in this study. This could have potentially skewed the search results of articles for further review, and possibly account for the notable absence of PEC-specific research originating in South America, Africa, or Asia.

Conclusion

While there is considerable interest in furthering PEC quality measurement, current publications are restricted to isolated pockets of activity and lack generalizability. Support from professional emergency care societies, or those with a vested interest in PEC, is required to further the prioritization of, and participation in, the development of PEC quality measurement. In addition, closer attention to the details and reporting of QIs is required for research of this type to be more easily extrapolated and generalized.

Author Contributions

IH, VL, PC, LW, and MC conceived the study. IH and VL conducted the data collection and analysis. IH drafted the manuscript, and all authors contributed substantially to its revision. IH takes responsibility for the paper.

References

1. Myers JB, Slovis CM, Eckstein M, et al. Evidence-based performance measures for Emergency Medical Services systems: a model for expanded EMS benchmarking. *Prehosp Emerg Care*. 2008;12(2):141-151.
2. Maio RF, Garrison HG, Spaire DW, et al. Emergency Medical Services outcomes project I (EMSOP I): prioritizing conditions for outcomes research. *Ann Emerg Med*. 1999;33(4):423-432.

3. O'Connor RE, Slovis CM, Hunt RC, Pirrallo RG, Sayre MR. Eliminating errors in Emergency Medical Services: realities and recommendations. *Prehosp Emerg Care*. 2002;6(1):107-113.
4. Moore L. Measuring quality and effectiveness of prehospital EMS. *Prehosp Emerg Care*. 1999;3(4):325-331.
5. Dunford J, Domeier RM, Blackwell T, et al. Performance measurements in Emergency Medical Services. *Prehosp Emerg Care*. 2002;6(1):107-113.
6. Studnek JR, Garvey L, Blackwell T, Vandeventer S, Ward SR. Association between prehospital time intervals and ST-elevation myocardial infarction system performance. *Circulation*. 2010;122(15):1464-1469.
7. Takahashi M, Kohsaka S, Miyata H, et al. Association between prehospital time interval and short-term outcome in acute heart failure patients. *J Card Fail*. 2011; 17(9):742-747.
8. Pons PT, Haukoos JS, Bludworth W, Cribley T, Pons KA, Markovchick VJ. Paramedic response time: does it affect patient survival? *Acad Emerg Med*. 2005; 12(7):594-600.
9. Pons PT, Markovchick VJ. Eight minutes or less: does the ambulance response time guideline impact trauma patient outcome? *J Emerg Med*. 2002;23(1):43-48.
10. Blackwell TH, Kline JA, Willis JJ, Hicks GM. Lack of association between prehospital response times and patient outcomes. *Prehosp Emerg Care*. 2009; 13(4):444-450.
11. Stirling CM, O'Meara P, Pedler D, Tourle V, Walker J. Engaging rural communities in health care through a paramedic expanded scope of practice. *Rural Remote Health*. 2007;7(839):1-9.
12. Woollard M. The role of the paramedic practitioner in the UK. *J Emerg Prim Heal Care*. 2006;4(1):1-9.
13. O'Meara PF, Tourle V, Stirling C, Walker J, Pedler D. Extending the paramedic role in rural Australia: a story of flexibility and innovation. *Rural Remote Health*. 2012; 12(1978):1-13.
14. Cooper S, Grant J. New and emerging roles in out of hospital emergency care: a review of the international literature. *Int Emerg Nurs*. 2009;17(2):90-98.
15. Spaite DW, Maio RF, Garrison HG, et al. Emergency Medical Services Outcomes Project (EMSOP) II: developing the foundation and conceptual models for out-of-hospital outcomes. *Ann Emerg Med*. 2001;37(6):657-663.
16. Garrison HG, Maio RF, Spaite DW, et al. Emergency Medical Services Outcomes Project III (EMSOP III): the role of risk adjustment in out-of-hospital outcomes research. *Ann Emerg Med*. 2002;40(1):79-88.
17. Maio RF, Garrison HG, Spaite DW, et al. Emergency Medical Services Outcomes Project (EMSOP) IV: pain measurement in out-of-hospital outcomes research. *Ann Emerg Med*. 2002;40(2):172-179.
18. Siriwardena AN, Shaw D, Donohoe R, Black S, Stephenson J. Development and pilot of clinical performance indicators for English ambulance services. *Emerg Med J*. 2010;27(4):327-331.
19. Mainz J. Defining and classifying clinical indicators for quality improvement. *Int J Qual Heal Care*. 2003;15(6):523-530.
20. McGlynn E, Asch SM. Developing a clinical performance measure. *Am J Prev Med*. 1998;14(3 Suppl):14-21.
21. Rubin HR, Pronovost P, Diette GB. From a process of care to a measure: the development and testing of a quality indicator. *Int J Qual Health Care*. 2001;13(6):489-496.
22. Ballard DJ. Indicators to improve clinical quality across an integrated health care system. *Int J Qual Health Care*. 2003;15(Suppl 1):i13-i23.
23. Arksey H, O'Malley L. Scoping studies: towards a methodological framework. *Int J Soc Res Methodol*. 2005;8(1):19-32.
24. Levac D, Colquhoun H, O'Brien KK. Scoping studies: advancing the methodology.
25. National Quality Forum. Measures, Report, and Tools. www.qualityforum.org.
26. Agency for Healthcare Research and Quality. AHRQ Web site. https:/www.ahrq.gov.
27. National Quality Measures Clearinghouse. National Quality Measures Clearinghouse Web site. ww.qualitymeasures.ahrq.gov.
28. Donabedian A. The quality of care. *How can it be assessed? JAMA*. 1997;260(12): 1743-1748.
29. Norris RM. A new performance indicator for acute myocardial infarction. *Heart*. 2001;85(4):395-401.
30. Sobo E, Andriese S, Stroup C, Morgan D, Kurtin P. Developing indicators for EMS evaluation and quality improvement. *Jt Comm J Qual Improv*. 1992;27(3): 138-154.
31. Grudzen CR, Liddicoat R, Hoffman JR, Koenig W, Lorenz KA, Asch SM. Developing quality indicators for the appropriateness of resuscitation in prehospital atraumatic cardiac arrest. *Prehosp Emerg Care*. 2007;11(4):434-442.
32. Daudelin DH, Kulick ER, Amore KD, Lutz JS, Barrientos MT, Foell K. The Massachusetts Emergency Medical Service Stroke Quality Improvement Collaborative 2009 - 2012. *Prev Chronic Dis*. 2013;10.
33. Rosengart MR, Nathens AB, Schiff M. The identification of criteria to evaluate prehospital trauma care using the Delphi technique. *J Trauma*. 2007;62(March):708-713.
34. Santana MJ, Stelfox HT. Development and evaluation of evidence-informed quality indicators for adult injury care. *Ann Surg*. 2014;259(1):186-192.
35. Patterson PD, Lave JR, Martin-Gill C, et al. Measuring adverse events in helicopter Emergency Medical Services: establishing content validity. *Prehosp Emerg Care*. 2013; 18(1):35-45.
36. Stelfox HT, Bobranska-Artiuch B, Nathens A, SE S. A systematic review of quality indicators for evaluating pediatric trauma care. *Crit Care Med*. 2010;38(4):1187-1196.
37. Hoogervorst EM, van Beeck EF, Goslings JC, Bezemer PD, Bierens JJLM. Developing process guidelines for trauma care in the Netherlands for severely injured patients: results from a Delphi study. *BMC Health Serv Res*. 2013;13(1):79.
38. Oostema JA, Nasiri M, Chassee T, Reeves MJ. The quality of prehospital ischemic stroke care: compliance with guidelines and impact on in-hospital stroke response. *J Stroke Cerebrovasc Dis*. 2014;23(10):2773-2779.
39. Myers JB, Slovis CM, Eckstein M, et al. Evidence-based performance measures for Emergency Medical Services systems: a model for expanded EMS benchmarking - Myers benchmarking in EMS. *Prehosp Emerg Care*. 2008;12(1):141-151.
40. Valenzuela TD, Spaite DW, Meislin HW, Clark LL, Wright AL, Ewy GA. Emergency vehicle intervals versus collapse-to-CPR and collapse-to-defibrillation intervals: monitoring Emergency Medical Services system performance in sudden cardiac arrest. *Ann Emerg Med*. 1993;22(11):1678-1683.
41. Colwell C, Mehler P, Harper J, Cassell L, Vazquez J, Sabel A. Measuring quality in the prehospital care of chest pain patients. *Prehosp Emerg Care*. 2009;13(2):237-240.
42. Greenberg MD, Garrison HG, Delbridge TR, et al. Quality indicators for out-of-hospital Emergency Medical Services: the paramedics' perspective. *Prehosp Emerg Care*. 1997;1(1):23-27.
43. O'Meara P. A generic performance framework for ambulance services: an Australian health services perspective. *J Emerg Prim Heal Care*. 2005;3(3.
44. Stelfox HT, Straus SE, Nathens A, Bobranska-Artiuch B. Evidence for quality indicators to evaluate adult trauma care: a systematic review. *Crit Care Med*. 2011; 39(4):846-859.
45. Dunford J, Domeier RM, Blackwell T, et al. Performance measurements in Emergency Medical Services. *Prehosp Emerg Care*. 2002;6(1):107-113.
46. Nakayama DK, Saitz EW, Gardner MJ, Kompare E, Guzik E, Rowe MI. Quality assessment in the pediatric trauma care system. *J Pediatr Surg*. 1989;24(2):159-162.
47. Gitelman V, Auerbach K, Doveh E. Development of road safety performance indicators for trauma management in Europe. *Accid Anal Prev*. 2013;60:412-423.
48. Patterson PD, Probst JC, Moore CG. Expected annual emergency miles per ambulance: an indicator for measuring availability of Emergency Medical Services resources. *J Rural Health*. 2006;22(2):102-111.
49. Greenberg MD, Garrison HG, Delbridge TR, Miller WR, Mosesso VN, Roth RN, Paris PM. Quality indicators for out-of-hospital Emergency Medical Services: the paramedics' perspective. *Prehosp Emerg Care*. 1997;1(1):23-27.
50. Bevan G, Hamblin R. Hitting and missing targets by ambulance services for emergency calls: effects of different systems of performance measurement within the UK. *J R Stat Soc Ser A Stat Soc*. 2009;172(1):161-190.
51. Nakayama DK, Gardner MJ, Waggoner T. Audit filters in quality assurance in pediatric trauma care. *J Pediatr Surg*. 1993;28(1):19-25.
52. Willis CD, Gabbe BJ, Cameron PA. Measuring quality in trauma care. *Injury*. 2007;38(5):527-537.
53. Spaite DW, Valenzuela TD, Meislin HW, Criss E, Hinsberg P. Prospective validation of a new model for evaluating Emergency Medical Services systems by in-field observation of specific time intervals in prehospital care. *Ann Emerg Med*. 1993;22(4):638-645.
54. Pozner CN, Zane R, Nelson SJ, Levine M. International EMS systems: the United States: past, present, and future. *Resuscitation*. 2004;60(3):239-244.
55. Roudsari BS, Nathens AB, Arreola-Risa C, et al. Emergency Medical Service (EMS) systems in developed and developing countries. *Injury*. 2007;38(9):1001-1013.
56. Adnet F, Lapostolle F. International EMS systems: France. *Resuscitation*. 2004;63(1):7-9.
57. Lindström V, Bohm K, Kurland L. Prehospital care in Sweden. *Notfall + Rettungsmedizin*. 2015;18(2):107-109.
58. O'Brien J, Shortell S, Hughes E, et al. An integrative model for organization wide QI - lessons from the field. *Qual Manag Healthc*. 1995;3(4):19-30.
59. Øvretveit J, Gustafson D. Evaluation of quality improvement programmes. *Qual Saf Health Care*. 2002;11(3):270-275.
60. Margolis P, Provost LP, Schoettker PJ, Britto MT. Quality improvement, clinical research, and quality improvement research-opportunities for integration. *Pediatr Clin North Am*. 2009;56(4):831-841.
61. Perla RJ, Provost LP, Murray SK. Sampling considerations for health care improvement. *Qual Manag Health Care*. 2014;23(4):268-279.

Authors	Year	Number of QIs	Clinical	Airway Management	Asthma/ Airway Obstruction	Non-Traumatic Chest Pain/ACS	General/ Interventions/ Medications	OHCA	Seizures	Stroke	Trauma	Hypoglycemia
Norris RM et al [29]	2001	2				X						
Sobo EJ et al [30]	2001	26		X	X	X	X	X			X	
Grudzen CR et al [31]	2007	28						X				
Daudelin DH et al [32]	2013	5								X		
Rosengart MR et al [33]	2007	28			X		X				X	
Santana MJ et al [34]	2014	8										
Patterson P et al [35]	2014	13					X	X				
Siriwardena AN et al [18]	2010	22			X	X	X	X		X		X
Stelfox HT et al [36]	2010	29		X			X				X	
Hoogervorst EM et al [37]	2013	12					X					
Oostema JA et al [38]	2014	8								X		
Myers JB et al [39]	2008	12			X	X	X	X	X		X	
Valenzuela TD et al [40]	1993	2						X				
Colwell C et al [41]	2009	8				X						
Greenberg MD et al [42]	1997	18					X					
O'Meara P [43]	2005	21					X	X				
Stelfox HT et al [44]	2011	21		X			X	X			X	
Dunford J et al [45]	2002	15					X	X				
Nakayama DK et al [46]	1989	16					X	X				
Website Search	N/A	15		X		X	X				X	

Table 3. Quality Indicators – Clinical Domain
Abbreviations: ACS, acute coronary syndrome; OHCA, out-of-hospital cardiac arrest; QI, quality indicators.

Authors	Year	Number of QIs	Adverse Events	Comms/ Dispatch	Doc	Employee Focused	Financial	Performance Monitoring/ Audit/ Appraisal	Receiving Facility Interaction	Research	Resources/ Deployment	Service User Satis-faction	Time Intervals	Triage
Sobo EJ et al [30]	2001	26							X				X	
Rosengart MR et al [33]	2007	28		X	X			X	X		X		X	X
Santana MJ et al [34]	2014	8			X						X		X	X
Patterson P et al [35]	2014	13			X	X					X		X	
Gitelman V et al [47]	2013	13									X		X	
Stelfox HT et al [36]	2010	29	X	X	X			X	X				X	X
Hoogervorst EM et al [37]	2013	12		X					X				X	
Oostema JA et al [38]	2014	8									X		X	X
Patterson P et al [48]	2006	1									X			
Greenberg MD et al [49]	1997	18		X		X	X	X		X	X	X		
Bevan G et al [50]	2009	4											X	
O'Meara P [43]	2005	21				X	X		X		X	X	X	
Nakayama DK et al [51]	1993	1											X	
Stelfox HT et al [44]	2011	21			X			X	X		X		X	X
Willis CD et al [52]	2007	2			X								X	
Dunford J et al [45]	2002	15		X		X		X			X	X	X	
Spaite DW [53]	1993	16											X	
Nakayama DK et al [46]	1989	16	X						X		X		X	
Website Search	N/A	15	X		X									X

Howard © 2017 Prehospital and Disaster Medicine

Table 4. Quality Indicators – Non-Clinical Domain
Abbreviation: QI, quality indicator.